CHEMICAL
& METALLURGICAL
# ENGINEERING

DEPRESSION ACHIEVEMENTS NUMBER

THIS MONTH

• What is a depression achievement? Selling short on Amalgamated Can or holding onto your job? Doing the work of two men at half-pay for one or making beer kegs of stainless steel? Anyway, this issue is full to overflowing with every sort of achievement you can imagine. If there's some we've overlooked, won't you tell us about them? One very good reason we want to hear about *all* chemical engineering achievements since January, 1930, will be found on pages 226-229.

NEXT MONTH

• We all go out to Chicago. The A.I.Ch.E. will be there June 14-16, and about every other society including the new Process Industries group of A.S.M.E. and the Chicago Power Show are to feature "Engineering Week," June 25-30. As perhaps you've already heard, there's to be a Century of Progress International Exposition out there starting June 1. You'll be able to read about the activities in our June and July issues but here's hoping we see you on "The Midway"! Oh, yes, there'll be some more achievement articles in June, also blast furnace phosphoric acid, distillation, cooling, natural alkalis on the Pacific Coast, and an account of the electrochemists' doings up at Montreal and Shawinigan Falls.

Published monthly, $3 per year. Canada (including Canadian duty), $3.50. Central and South American countries, $3.00. Foreign subscriptions, $5.00 U. S. Currency, or 25 shillings. Single copies 35 cents each. Entered as second-class matter July 13, 1918, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.
Member A.B.C. and A.B.P.

McGRAW-HILL PUBLISHING COMPANY, INC.
330 W. 42d St., New York, N. Y. Cable Address McGrawHill, N. Y.

Branch Offices: 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treas.; Mason Britton, Vice-Pres.; Edgar Kobak, Vice-Pres.; H. G. Parmelee, Vice-Pres.; Harold W. McGraw, Vice-Pres.; B. R. Putnam, Secy.

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VOLUME FORTY NUMBER FIVE

CHEMICAL
& METALLURGICAL
# ENGINEERING

VOLUME 40 ESTABLISHED 1902 NUMBER 5

McGRAW-HILL PUBLISHING COMPANY, INC.

S. D. KIRKPATRICK, Editor

MAY, 1933

ADVANCING THROUGH ADVERSITY

"THAT GREAT VULCAN, we call hard times, is today forging the bands of character, bringing to keen temper the resilient spirit of men. Life is coming out of its glass case. It is becoming a gallant adventure for us all. As we advance through adversity, we shall find joy in difficulty; we shall give first and best energies to our greatest problems; we shall appraise rather than avoid opposition; we shall build new strength from vicissitude. What a day to be alive—when the world is making men!"

So Professor Schell, mentor extraordinary of M.I.T., recently wrote to each man who has graduated from his courses in engineering and business administration. His stimulating message, we feel, is one that should be shared by all chemical engineers. It expresses, better by far than any word of ours, the purpose that underlies this special-theme issue of *Chem. & Met.* Without attempting to minimize the severity of the depression, we want you to look at it now from a little different viewpoint.

In the face of all that has transpired since the Fall of 1929, it ill becomes any of us to boast of "depression achievements." Yet the record is one that should no longer be suppressed. Its very recital should encourage us to carry on with renewed vigor—to face and attack the difficulties that still lie in the path of recovery. As yet we have no definite proof that we are at the bottom, but in each of us there is a growing determination that this *must* be the turning point. Every effort must be bent in that direction. Unless we are willing to try, we cannot hope to achieve. That truth was centuries old when Chaucer said "He that naught nassayeth, naught nacheveth."

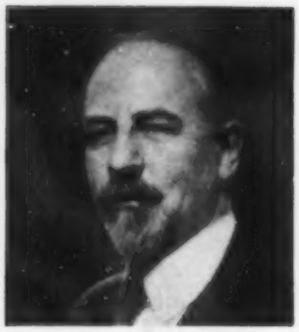
It is fitting that this issue should recount achievements—and there have been many of them in every phase of chemical engineering. Inventive ingenuity has been stimulated and accelerated. And in most instances it is the chemical engineer who has transformed the vision of the research worker into the practical achievement of industry. Necessity has dictated economies in operation, which have called for the most resourceful type of chemical engineering. Therefore, with all its disappointments and discouragements, the depression has offered the chemical engineer his first really great opportunity to demonstrate the full range of his abilities and thus to earn his place in industry.

Some recognition, we feel, should be given to those companies in the process industries that have helped most to carry forward the torch of chemical engineering progress. In this issue, *Chem. & Met.* announces a plan for such an award for meritorious achievement. It is to be presented for the first time at the Chemical Exposition in December. Between now and then a committee made up of distinguished engineers and executives will welcome your suggestions and cooperation in order that this award may prove truly representative. Achievement, so conceived, is broader than the accomplishments of any individual for it becomes a measure of the progress of the whole profession.

An AWARD for

CHEMICAL ENGINEERING ACHIEVEMENT

Sponsored by Chemical & Metallurgical Engineering



John V. N. Dorr

Charles E. Adams

Charles Belknap

CHEMICAL engineering has meant many things to many men. In the formative stages of its development, say in the years immediately following the outbreak of the World War, it was changing so rapidly that no two definitions would agree. Most people regarded it as a sort of hybrid of chemistry and some kind of engineering, and let it go at that. But the War gave the chemical engineer his real baptism of fire, from which he emerged with a fairly well accepted recognition of one of his most essential functions, namely, that of translating the chemical reactions of the laboratory into large-scale and profitable production in the plant.

But only very gradually has industry come to a realization that chemical engineering training and experience are so broad and at the same time so fundamental as to fit a man for many other duties than those of the specialist in handling production processes and equipment. A grounding in economics, experience in handling men and an ability to get at the fundamentals in any problem, have led many chemical engineers into executive positions, not only in production, but in sales, research and general administration.

For a number of years *Chemical & Metallurgical Engineering* has tried to encourage this broader participation of the chemical engineer in the affairs of the process industries, believing that both the industry and the profession would be benefited thereby. Considerable progress has been made, but it must be admitted that the chemical engineer has not been uniformly successful in making his influence felt in other than purely technical matters. In some whole industries he continues to serve as the hand-maiden of the so-called "practical man," often confined to the laboratory, except for an occasional assignment at trouble-shooting in the plant. In by far the largest number of plants, however, the chemical engineer's advance is through the plant engineering organization to a position of responsibility for production. Superintendents and works managers who are chemical engineers by training and experience are most numerous. Not so many have successfully negotiated the next hurdle into general executive and administrative work, where the financier, lawyer and the "business man" still reign supreme. There are enough exceptions, however—and prominently successful ones, too—to prove the case for the chemical engineering executive if ever it needs to be proved.

In setting up an Award for Chemical Engineering Achievement to be given to a *company* rather than to an individual, *Chem. & Met.* would like thus to accord public recognition to the very broad and important service which the chemical engineer is rendering in many industries today. It is felt that this can best be done by placing before a Committee of Award, made up of recognized leaders in the industry and profession, a series of brief statements outlining the achievements of a number of companies. These statements would lay emphasis on the part that chemical engineering personnel, processes and equipment have played in the particular development under consideration. They would cite sufficient of the history of the achievement to show its relation to research. Something of the philosophy of management underlying the whole project would seem to be desirable. What was the company's objective? How did it organize to approach that ob-

jective? What is the best measure of its success in reaching that objective?

Of necessity, all of the foregoing questions are general rather than specific and concrete. On a following page are given the very few rules and conditions that seem essential in order to carry out the broad purposes of the award.

What constitutes chemical engineering achievement on the part of a company? One definition might well be as follows:

The successful large scale commercial development of a process, group of processes or an entire company's business based on chemical research and actively organized, developed and operated through chemical engineering control and direction.

Harry A. Curtis

However, in order to present other viewpoints on this subject, *Chem. & Met.* has solicited the opinion of a number of outstanding authorities, including many of those who have agreed to serve on the Committee of Award. For example, Charles E. Adams, president of the Air Reduction Co., would define a chemical engineering achievement as "the successful reduction to industrial practice of a new manufacturing process within the chemical industry that offered sufficient economies in the manufacture of the product involved as to open a new and important field of use for that particular product."

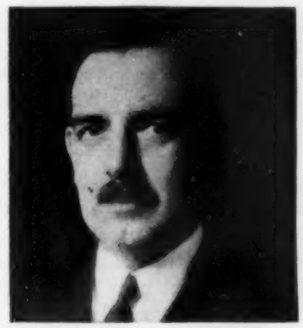
Dr. Harry A. Curtis, director of research and development for the Vacuum Oil Co., cites the following specific fields in which a company may have made an outstanding chemical engineering achievement:

A. The development of a chemical process from the laboratory stage through the various intermediate steps to full-scale operation.

B. The improvement in design and arrangement of equipment in the interests of economy, through intelligent application of chemical engineering principles, facts and technique.

C. Improvement in yield, capacity of installed equipment and in quality of product, through studies of plant operation.

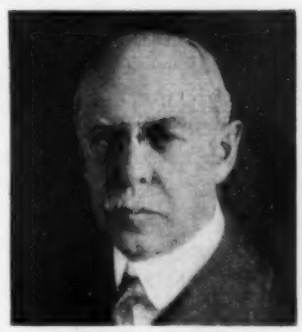
D. In managerial positions where knowledge of chemical engineering permits a better evaluation of proposed processes and changes in equipment and operation.



Albert E. Marshall

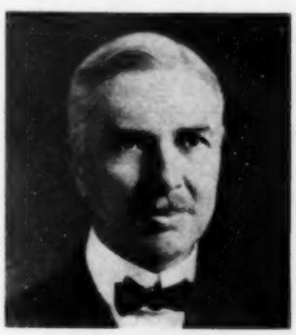
Dr. Arthur D. Little would extend his definition of a chemical engineering achievement "to include the development of an important piece of equipment, the design of which exhibits chemical engineering ability of a high order." By way of illustration he refers to the Townsend cell, the Cottrell precipitator and the Herreshoff furnace.

Prof. Alfred H. White, head of the Department of Chemical Engineering at the University of Michigan, has expressed the view that an award might well be made "in recognition of industry's responsibility in the training of chemical engineers by extending to teachers and students those facilities for learning how theoretical training must be applied in order that it may be useful to the world."



Arthur D. Little

Charles Belknap, president, and some of his associates in the Merrimac Chemical Co., believe that this award should in some way recognize the practical value that arises from chemical engineering participation in merchandising and otherwise capitalizing on the results of scientific accomplishment in research and production. They also cite the importance of making



Alfred H. White

M. C. Whitaker

Walter A. Schmidt

the award to a company rather than to an individual "because it is recognition of a type of achievement that can only be brought about by the coordination of the efforts of a whole chemical engineering organization working in unison."

To show that the work of the chemical engineer in research and development is considerably broader than the conventional functions of design, construction and operation, Dr. Curtis also cites the procedure by which a process is developed today in some of the larger petroleum companies:

A. A study of the scientific fundamentals of the proposed process in order to gain some preliminary idea as to its feasibility, and particularly to show what further small-scale experimental work is necessary.

B. The development of additional information as to yield, production, temperature effects, etc., using apparatus which may be anything from test tubes and beakers up to chemical engineering laboratory equipment.

C. A frequent re-evaluatio nof the commercial feasibility of the process.

D. Design, set-up and operation of a small-scale unit in the chemical engineering laboratory.

E. Design, construction and operation of the semi-commercial unit based on all available information at this point.

F. Final evaluation of the commercial feasibility of the process.

G. Cooperation with the builders of plant equipment and the engineering construction department in the design and erection of the first commercial unit.

H. Cooperation with the manufacturing department in putting the commercial unit into successful operation.

Albert E. Marshall, after a careful study of conditions surrounding all of the awards now available in chemical industries, concludes that this plan does not conflict with any existing medal or award, because it proposes recognition of the achievements of a corporate organization and will not be based on the work of an individual or single department within a company. He holds that the award might at some time logically go "to a firm which had established an outstanding record as a direct result of the close cooperation of the executive, engineering, research and production divisions." He states further:

Achievement in the sense of dollars earned by an organization is not necessarily achievement from the standpoint of chemical engineering or management, so that the committee should not be influenced solely by financial success. It is not at all impossible that at some time the award should legitimately be made to a corporation that would normally class as a semi-financial failure.

Dr. M. C. Whitaker, vice-president of the American Cyanamid Co., also warns against the misjudgment of a chemical engineering achievement solely on the basis of economic results. He writes:

I have seen some very successful chemical engineering work accomplished, involving the highest order of engineering talent on processes which turned out to be economically unsound, due to causes quite outside of the scope of the chemical engineers involved. I am one of those who believe that chemical engineering should not necessarily be tagged with economic failure of process simply because high-priced executives, who pose as economic and business experts, fail to function. In most of these organizations there should be a division of labor in which the members of each unit assume full responsibility for the phase of the job for which their training and experience qualify them.

In most worthwhile chemical engineering achievements, a great many people are involved. If you undertake to unscramble and assign credit to the individual or division or if you undertake to arrange the group in their order of importance, you will have a lot of trouble. In the few developments with which I have been connected, it has never been possible for me to allocate the credit, no matter how hard I tried. I have always preferred, therefore, to treat the subject as the work of the group. The woods are full of medals for individual achievements, and it seems to me that this award might be advantageously directed to group achievement.

The latter view is also very well expressed by Walter A. Schmidt, president of the Western Precipitation Co.:

In my opinion there is much in favor of the proposed plan of giving an award to a company in recognition of chemical engineering achievement. While we all recognize the importance of honoring individual achievement, we should not overlook the fact that most present-day develop-

COMMITTEE OF AWARD

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President, American Institute of Chemical Engineers

CHARLES E. ADAMS
President, Air Reduction Co.

CHARLES BELKNAP
President, Merrimac Chemical Co.,
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ARTHUR D. LITTLE
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ALBERT E. MARSHALL
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Vice Pres., American Institute
of Chemical Engineers

WALTER A. SCHMIDT
President,
Western Precipitation Co.,
Director, American Chemical Society

M. C. WHITAKER
Vice Pres., American Cyanamid Co.
Director, American Chemical Society

ALFRED H. WHITE
Professor of Chemical Engineering,
University of Michigan

SIDNEY D. KIRKPATRICK,
Secretary
Editor, Chemical & Metallurgical Engineering

ment work calls for group activity, and such work is usually impossible to evaluate in terms of the importance of one man's contributions with respect to those of another. Furthermore, such work often finds its inspiration in the foresight, courage and leadership of some man who takes no direct part in the technical work. Giving recognition for an outstanding major achievement to a company places emphasis on the worth of a well-coordinated organization and the value of a high *esprit de corps* among and between the technical men and the business management.

The value of individual research is fundamental and must be rewarded, but the importance of group activity is likewise far-reaching and should also be recognized. The proposed plan of giving honorary awards to companies responsible for outstanding achievements in chemical engineering is fundamentally sound.

Rules and Conditions Governing
AWARD FOR CHEMICAL ENGINEERING ACHIEVEMENT

1. The purpose of this award is to give public recognition to the company in the process industries that through the effective use of chemical engineering in any phase of its activity has contributed the most meritorious advance to the industry and profession.

2. The award is to consist of an appropriate bronze plaque suitably engraved to indicate the nature of the achievement and the name of the company to which it is presented.

3. The first award is to be made at the time of the National Exposition of Chemical Industries which will be held in New York City during the week of December 4, 1933. The first award applies only to industrial developments that have come to fruition since January, 1930. Subsequent awards will be confined to developments occurring in the intervals between the National Exposition of Chemical Industries.

4. The award is to be made only to a company in the process industries since it is a recognition of the achievement of a corporate organization rather than that of any individual or department within a company. However, any company or any of its subsidiaries would be eligible for the award on the basis of any number of achievements brought to the attention of the committee.

5. The Committee of Award shall consist of nine men, recognized as leaders in the industry and profession. It should include representatives of the American Institute of Chemical Engineers and the Manufacturing Chemists' Association. One of the members of the Committee of Award is to be designated as the chairman, and the editor of *Chem. & Met.* is to serve as secretary of the committee but without voting power. It is expressly understood that no member of the committee would be asked to pass on the merit of entries made by any company with which he is affiliated. In other words, any member would have the privilege of withdrawing at any time should the consideration of a company's name prove likely to be embarrassing in personal or business relations. In such case the member of the committee would be reported as "not voting."

6. It is to be the function of the committee to review the achievements in the field, to receive suggestions from all sources and to determine which company has, in their judgment, contributed the most meritorious chemical engineering achievement during the interval under consideration.

7. Any company in the process industries desiring to be considered for this award may file an application merely by answering the following inquiries:

(a) What is the nature of the achievement?

(b) During what period was it effected?

(c) To what extent have chemical engineers participated in this development?

(d) Are there any supplementary records, data, articles or references which you would care to include as pertinent to a fair consideration of this achievement?

8. It is expressly understood that the award is not to be limited to those companies who file formal applications with the committee, since suggestions are welcome from any source that will assist in directing the attention of the committee to achievements of companies that should have consideration. All communications should be addressed to the Secretary, Committee of Award, *Chemical & Metallurgical Engineering*, McGraw-Hill Building, New York City.

CHEMICAL ENGINEERING MARCHES ON!

FIGHTING a war and fighting a depression have much in common. Certainly, those four desperate years, 1914 to 1918, have had almost their exact counterpart in the world-wide struggle since Autumn of 1929. Now, as then, we have been engaged in a war from which no nation, industry or individual has escaped entirely unscathed. Battles have been waged on so many fronts, with such diverse and often discouraging results that at times defeat has seemed inevitable. Yet, in spite of setbacks and terrific losses, we have somehow carried on. Progress has been made and chemical engineering has had an important part in that progress. It is a record of which we may well be proud.

Just as a nation mobilizes its forces in times of war, so industrial management marshalled its resources to fight the depression. Almost immediately, there was a wholesome change in attitude toward anything that could contribute to increased efficiency of operations. It was obvious that the days of increasing profits through expanding capacity were definitely over. Operating economies and improved processes constituted the first line of attack and the burden of much of this effort fell on the shoulders of chemical engineers. Then, when the commodity markets continued to decline, there came an increased emphasis on new products or radical improvements in quality and appearance of existing products. Again, the chemical engineer, working closely with the laboratory chemist, was called upon to translate the results of research into commercial production with the minimum expenditure of time and money.

When did the depression hit chemical industry? Certainly, it was not in 1929, for the records of that year are the highest in the history of the industry. It was not in 1930, for many of the large construction and development programs were just then getting under way. Trona, Trail, and Shell on the Pacific Coast, the hydro-plants of Standard Oil, the rapid growth of Cellophane and rayon, Tennessee Eastman's change to cellulose acetate; the expansion at Hopewell, Carbide's progress at South Charleston, Merrimac's modernization, Bakelite's new plant, and the splendid research laboratories of the Aluminum Co., of Hercules and Vacuum Oil, to mention but a few—all of these meant real activity in chemical engineering. Naturally, many of these carried over well into 1931 and the urge for new products continued unabated.

By the time the third year rolled around, however, it was evident that the drive for economy was beginning to take effect in chemical industry, reducing employment and sending production farther on its sickening descent. The new-old creed of Technocracy began to win a few converts and started everyone thinking along social lines. Perhaps it was a good thing. Certainly, technical advances made without thought of their social implications had contributed in some measure to our troubles. To help in correcting this situation, the Manufacturing Chemists' Association took the lead in adopting the six-hour shift, and otherwise helping the spread-the-work program. A few companies, Monsanto prominently among them, were able to raise wages and increase employment, at the same time building up business. Many modernization and industrial rehabilitation programs were carried on largely for the purpose of keeping people at work. And now, in the fourth, and we hope the last year of this struggle, we begin the reconstruction with a firmer determination to end the drastic processes of deflation —to start anew from the present low levels of industrial activity.

Outstanding, by far, are the record advances in the synthetic organic chemical industries. Here is almost the ideal field for the play of the creative forces of

research. One of the few unshrinkable assets carried over into the depression was the accumulation in the laboratories of workable plans for many new products, processes and projects. Carbide and Carbon Chemicals serves as an excellent example. The pioneering research on the olefine hydrocarbons carried on at Mellon Institute during and immediately after the War, laid the basis for a huge new industry. By 1929 an impressive commercial development of ethylene glycol and related products was already under way, but this was only the forerunner of a string of chemical engineering developments. Synthetic acetone manufacture was the first "depression achievement" and it practically revolutionized existing practice. Calcium acetate from wood distillation or corn fermentation were no longer the prime sources of this material. In 1930 came the announcements, first of synthetic ethyl ether and then of synthetic ethyl alcohol. In the face of keen competition from the fermentation industry, these new products became firmly established as commodities of commerce. Then synthetic methyl and butyl alcohols followed much the same course and the list of commercial synthetic organic chemicals continued to grow as new derivatives became available for literally hundreds of chemical uses. In this connection the vinyl resins, first produced on a commercial scale in 1929, deserve special mention and will be discussed later in connection with their use as plastics.

Meanwhile, paralleling the progress at South Charleston was the neighboring duPont enterprise at Belle, W. Va., where the high pressure synthesis of methanol and higher alcohols must take rank as a leading achievement of the depression. By 1930, when synthetic methanol reached its peak of 12,500,000 gal., production from wood distillation had dropped to less than 5,000,000 gal. and continued to decline to less than 2,000,000 in 1932. The higher alcohols, finding use in such varied applications as organic synthesis, as industrial alcohol denaturants and anti-foam compounds, have assumed new importance.

Synthesis of phenol from benzol had its start before the depression but was rapidly expanded by Dow Chemical and by Monsanto. The latter uses the method which supplied most of the phenol required for wartime purposes. In this process benzene is sulphonated, the resulting benzene sulphonic acid is neutralized and the sodium benzene sulphonate is fused with caustic soda. Monsanto greatly improved and simplified the process by increasing the conversion in the sulphonation reaction, by elimination of the cumbersome liming process for removing the excess of sulphonic acid and by the utilization of the sodium sulphite which is formed as the byproduct. The Dow process consists of chlorinating benzene and heating the resulting chlorbenzene with caustic soda under high pressures. It had its principal development in 1929 and has been credited by Dr. Jules Bebie as "one of the outstanding accomplishments of recent chemical research and engineering." In 1929 it probably supplied more than half of the total production of this important commodity. The process is of further interest because it gives as a byproduct, diphenyl oxide, the use of which as a heat transfer medium is now assuming increased importance.

Reference should be made at this point to the Swan development of diphenyl, likewise of interest as a heat transfer medium but more conspicuous recently in the form of its chlorinated derivatives known as the Aroclors. These new compounds have many uses, one of the most interesting of which is as a non-flammable transformer oil in electrical applications.

Plastics Mold Progress

Practically all of the base materials for modern plastics were well known and being produced on a fair scale at the start of the depression. The phenolic-aldehyde materials, the nitrate and acetate esters of cellulose, urea-formaldehyde products, glycerin-phthalic anhydride resins, the polymerized styrol and vinyl compounds—all had established themselves to a greater or lesser extent by 1929. What has happened since has come largely from intensive commercial development, both in manufacture and application. New plasticizers, solvents and better raw materials have helped, but, after all, the most important contributions have been in perfecting production technique. With larger outputs have come lower costs, which in turn, have opened new markets.

Among very recent achievements is the production of synthetic camphor by a new process started about two months ago by the duPont company in a plant built at Deepwater Point, N. J. The process is the outgrowth of research and development conducted over several years by the dyestuffs division of the duPont and Newport companies. Capacity of the plant is said to be large enough to take care of a considerable part of the normal requirements of the United States for this important material, long controlled by a foreign monopoly.

Painstaking research was required in the development of the process, from the laboratory to the commercial stage. This was done without losing sight of the possibility of price competition from European manufacturers and from the producers of natural camphor in the Far East. Chemical engineering research has been equally thorough. Before the plant was built, a model was carefully made to scale with

miniature equipment in place to permit the operating staff to visualize their work and make changes in construction and design before starting building operations. Although the plant has not yet operated long enough to furnish complete data regarding yields, the results obtained give promise of success.

Before leaving the field of organic synthesis, some reference should be made to the new refrigerant, dichloro-difluoro-methane, announced by Midgley and Henne before the Spring meeting of the A.C.S. in 1930. On the basis of this development, Frigidaire and duPont have already built a new process industry which has not been talked about very much but seems to hold a strategic position in the refrigeration field. It has brought about some interesting chemical engineering developments, for example, the production and transportation in special steel tank cars of the large quantities of anhydrous hydrofluoric acid required in its manufacture.

Ask the fertilizer manufacturer what was his principal achievement during the depression, and he'd likely answer, "To exist at all." That is measurably true, despite the fact that 1930 was the best year the industry had had since 1919. But 1932 was by far the poorest. In its technical aspects the fertilizer industry, particularly those branches that supply it with its basic chemicals, have been extremely active. Since 1929 productive capacity for synthetic nitrogen has more than trebled and last year, for the first time in history, we exported more sodium nitrate than we imported from Chile. The latter's former world monopoly has proved a dwindling asset, particularly to those who in 1930 helped to launch the huge and top-heavy corporation known as Cosach by subscribing to its $375,000,000 of capital stock. But neither has the synthetic industry prospered during the past three years for prices have fallen to levels never imagined in 1929.

From a chemical engineering view, the most interesting achievements have had to do with the introduction of nitrogen into the mixed fertilizers of commerce. Direct ammoniation of superphosphate, using either ammonia liquor or anhydrous ammonia, had its start on a fairly large scale early in 1929 and continued with considerable success until the tremendous decline in the price of ammonium sulphate during the 1930-31 season. In the Fall of 1932, the ammonia department of E. I. duPont de Nemours & Co. publicly announced the development of urea-ammonia liquor, which for a year had been used on an experimental scale in a number of fertilizer plants. Crude urea synthesized in a new division of the plant at Belle, W. Va., is dissolved in aqua ammonia to give a solution containing 55 per cent of total ammonia—a third of which is present in the organic form of the desirable fertilizer constituent urea. The economy in transportation and ease of application have helped to establish this new product.

Concentrated fertilizers, once held forth almost universally as the ultimate chemical solution for the industry's many problems, became the center of debate among agronomists late in 1931. This resulted in a rather clear cleavage of the field with many of the older and larger companies preferring to continue the gradual trend rather than striking out boldly with products of extremely high analysis. In the meantime, however, several new types of these materials did appear on the market or were put through exhaustive experimentation. A new drillable fertilizer containing up to 70 per cent of actual plant food was developed in a unique process by the Swann organization and extended tests were made in 1931 and 1932.

Fertilizer Phosphorus

Plans for the production of phosphoric acid at Muscle Shoals by an electric furnace process did not get beyond the discussion stage, but they clearly emphasized the keen interest that underlies the phosphorus element in the familiar trinity of the fertilizer industry. But while these plans were being talked about, Victor Chemical Works proceeded with the development of its furnace plant near Nashville, Tenn., and its successful operation is generally regarded as one of the real achievements of the depression. Coke is used there to make phosphorus compounds in a furnace much like a pig-iron blast furnace. Within the past few weeks there has been another development in the fuel-fired furnace business. Oldbury Electrochemical Co., long established British-owned phosphorus producer of the Niagara Falls district, has taken over the controlling interest from Coronet Phosphate Co. in the phosphoric acid and affiliated chemical activities at Pembroke, Fla. Under the name of the Pembroke Chemical Co. it will presumably continue the development and commercialization of the blast furnace process, installed and operated there on an experimental basis.

The products of these three companies are directly competitive with phosphoric acid, superphosphate and other products of phosphate rock made by wet processes with sulphuric acid. Competition between wet process and furnace acid promises to be more keen through the use of improved methods of producing stronger acids as were developed by the Dorr Co. and applied for the first time in the plant of the Consolidated Smelting & Refining Co. at Trail, B. C. What all of this competition means in relation to Muscle Shoals is still a matter of conjecture, but probably no field of chemical engineering activity is quite so interesting as the production today of fertilizer phosphorus.

At last, we can safely proclaim American independence for the third essential of the fertilizer industry. So much has been published in *Chem. & Met.* recently regarding the potash development at Carlsbad, New Mexico, that the reader must be referred to these accounts, particularly the one appearing last month. Suffice it here to say that the achievement of the U. S. Potash Co. in putting down its mine and erecting its refinery is one that must be regarded of prime importance from an industrial as well as a nationalistic viewpoint.

Sulphur and Sulphuric Acid

Texas Gulf's modernization and expansion program at New Gulf, Texas, may have anticipated the depression by a few months, but it marked the beginning of real activity in this basic industry. The new plant described in *Chem. & Met.* in November, 1930, put the Frasch process on a really sound chemical engineering basis. Refinements in water softening and purification, steam generation and transmission and in materials handling, represented almost the last word in modern equipment. In the meantime Texas taxes began to menace the industry and sulphur prospectors turned to Louisiana. A small but rather enterprising production got under way at Jefferson Island last year and then a little later, Freeport Sulphur, the second largest producer, announced its plans for constructing a sulphur mine in the tidewater marsh region at Lake Grande Ecaille in Plaquemines Parish. So Louisiana makes its bid to recover the laurels it lost to Texas, but it is only fair to state that it has a long way yet to go.

The principal depression achievement of the sulphuric acid business seems to be the ability to hang on in the face of present prices. Technically, the industry has been enlivened by some interesting litigation and some occasionally heated discussion of the relative merits of the platinum and vanadium catalysts. (See *Trans. A. I. Ch. E.*, vol. 27, 1931, pp. 264–309.) With the price of the former metal down to $30 instead of $100 an ounce, the proponents of each catalyst seem to be able to go at it hammer and tongs without very definite advantage on either side.

The late Ingenuin Hechenbleikner, inveterate inventor and industrialist, contributed many notable advances to chemical industry. Probably the crowning achievement of his long career was the acid recovery process which was having its first commercial test near Pittsburgh at the time of his sudden death on Sept. 15, 1932. The Hechenbleikner process, as it is now called, utilizes the heavy unseparated acid sludge from an oil refinery as raw material for sulphuric acid production by the contact process. The sludge is heated in a single walled rotary kiln by the hot gases from a fuel oil burner. Under controlled conditions thus obtained, the hydrocarbons in the sludge reduce the sulphates, sulphonates, and any free acid present in the sludge to form a gas containing approximately 20 per cent of sulphur dioxide. The carbon residue leaves the kiln as dry coke.

The gas is then scrubbed with water, dried with strong acid and passed over a vanadium catalyst in the converter for the production of water-white acid of 98 per cent or higher strength. The whole process gives an over-all recovery of about 85 per cent but additional sulphur may be burned to make up the 15 per cent loss or to produce any desired quantity of acid up to the capacity of the plant. Thus the refiner who adopts the process becomes independent of other sources of acid supply.

The original experimental work on the process was done in the plant of the Chemical Construction Corp. in Charlotte, N. C., where a two-ton-per-day experimental unit was built and operated in the Spring of 1931. The first commercial plant, having a capacity of 50 tons per day, was built for W. H. Daugherty & Sons Refining Co. at Petrolia, Pa., and started operations in June, 1932. If the results of the first year's operation completely substantiate the very high claims made for it, the Hechenbleikner process promises a tremendous advance for the oil industry.

Heavy Chemical Developments

Just about the time bleaching powder seemed to be destined to pass completely out of the picture, Mathieson came along with HTH, a high-test hypochlorite on which more than eight years of research had been expended. Having almost twice the available chlorine of ordinary bleach and unusual stability besides, the new product was quickly accepted and in spite of the depression has made a spectacular advance to a substantial market.

Among other recent developments is the commercial production of crystalline sodium metasilicate, which is now taking its place among the industrial alkalis. Although the crystalline product has been known for a century, difficulties in its manufacture have long prevented its commercial use. In December, 1930, the Philadelphia Quartz Co. announced the successful production of a granular, free-flowing material to which it gave the trade name, Metso. The manufacturing process as revealed in C. L. Baker's patent granted Feb. 21, 1933, involves the treatment of sodium silicate with caustic soda and the careful adjustment of the water content to obtain crystallization of a product of the desired composition.

Sodium metasilicate is rapidly gaining in importance as an industrial detergent. Materials subject to injury when treated with ordinary alkalis may be cleaned with a relatively strong metasilicate solution applied

for a short time and promptly rinsed off. It is used to good advantage in laundries, in food industries, for cleaning metals, for removing oil and grease, for washing soiled rags as the first step in making high-grade paper and in the de-inking of paper stock. Because it is a good solvent for casein and protein, it is a useful component in coating mixtures and adhesives.

Hydrogen peroxide is another compound to come into recent prominence as an industrial chemical. Some idea of its new importance may be gained by the fleet of very new 8,000-gal. aluminum tank cars that ply between the electrochemical plant at Buffalo and the Southern cotton mills where the product is used in bleaching towels and similar goods.

Bromine and Iodine Cut Capers

Bromine and iodine have proved an interesting pair during most of the depression. When Ethyl gasoline started on its way to popularity about 1925, bromine consumption increased by leaps and bounds. Dow Chemical's rapidly expanding output from its brine wells was supplemented by that of the California Chemical Corp. obtained from bitterns and in 1932, the Texaco Salt Products Co. erected a $2,000,000 plant to extract this element from a deep-well brine in Oklahoma by the Martin process. Dickinson, pioneer in the Kanawha Valley and a few Ohio producers made up the total. But apparently even Ethyl began to feel the depression last year and this was promptly reflected in bromine consumption. New uses were in urgent demand and out on the Pacific Coast the enterprising Californians produced a new brominator for water supplies and demonstrated that one part of bromine would do the work of five parts of the old stand-by, chlorine. Other outlets are developing, stimulated to some extent by a new type of tank car that will greatly reduce transportation cost for anhydrous bromine.

Iodine, another one of Chili's former monopolies hasn't exactly paralleled the bromine development but it is on its way. Two American plants on the Pacific Coast and another in Louisiana are our best insurance that iodine will never again soar to $4 per lb.

Removal of excess salt from electrolytic caustic soda, always a knotty problem, appears to have been solved recently in an ingenious manner through the joint efforts of Pennsylvania Salt Manufacturing Co. and Canadian Industries, Ltd. Three plants on the American continent now use the patented Pritchard process in which sodium sulphate is added to throw down a triple salt with NaCl and NaOH. Another Niagara plant is said to accomplish the same purpose by refrigerating the caustic to crystallize out a hydrate, $NaOH.3\frac{1}{2}H_2O$, while leaving the NaCl in the mother liquor.

Another alkali that looms on the horizon is purified alumina, which right now finds its chief market in Hall process aluminum but is being used in increasing quantity in sodium aluminate for water purification. Activated alumina—an alumina-gel, if you will—shows extremely interesting properties as an adsorbent. Aluminum foil insulation is an important development in which the first work was done in Germany but has since been transplanted to American soil.

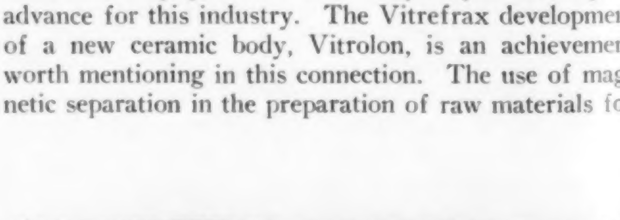
Ceramics have felt the depression somewhat more severely than the process industries in general, and many of them have turned wholeheartedly toward the development of new products. The glass industry is looking toward the resumption of building and is going to offer at least two varieties of glass bricks which will permit numerous interesting color combinations and effects never before attained. Corning was first with a five-sided, open-top model, made of its famous Pyrex and therefore heat and fire-resistant. As placed in the impressive arch for the main entry to the new Radio City, the Corning bricks are "mortared" with transparent Vinylite resins. The Libbey-Owens-Ford brick is a six-sided affair with the sixth side cemented in after molding in order to avoid condensation of moisture within the brick. By the use of colored cement, very effective results are obtained which would otherwise require much more extensive colored glass.

A development of the glass industry which received wide publicity in the technocratic press is the famous Corning bulb machine. (N. B. *Chem. & Met.* had already published its article in June, 1932.) With a capacity of about 450 bulbs per minute, even the nimble-fingered Japs had better look to their cheap electric light bulb laurels.

De-airing—A Ceramic Advance

In the heavy clay industries, the de-airing of the clays is one of the most interesting and important developments of recent years. Actually the original research goes back about 30 years and one company is said to have employed it for the last six. The major developments have been within the last two or three years. De-airing vastly improves the working properties, drying and firing behavior of the products. Maurice Knight has been the first to apply it to chemical stoneware. A movement is afoot to employ the process also in the production of casting slips.

Tungsten carbide tools have recently been employed in the cutting and turning of ceramic materials such as insulators. It requires only a few seconds to turn a perfectly smooth face on a porcelain disk six inches in diameter by this new method. Automatic machinery has recently been developed for manufacturing dinnerware and may prove to be a very important step in advance for this industry. The Vitrefrax development of a new ceramic body, Vitrolon, is an achievement worth mentioning in this connection. The use of magnetic separation in the preparation of raw materials for



the ceramic industry is an important development that has spread rapidly since its original application in the production of special feldspar for the glass industry.

Rayon's real achievement in the depression came when it had the courage to shut up shop in the summer of 1932 in order that consumption could catch up with production schedules. But on the opposite side of the ledger are the startling reductions in price that for a time threatened to pull the whole industry into the red. From a technical standpoint, a leading place must be given to the Furness process which went into production during the past year at Gloucester City, N. J. In one spinning machine, the cuprammonium solution is spun, coagulated, decopperized, washed, dried and twisted and wound on bobbins as finished yarn. Costs are said to be far below the standard process, because of the smaller investment in expensive equipment and much smaller labor requirement. Furthermore, its inventor envisions the shipping of cuprammonium solution in tank cars to textile mills who need only put it through the spinning machinery to "roll their own" rayon. The process has gone far enough to prove its technical and economic soundness.

The trend toward delustered fabrics started considerably before 1929, but every branch of the rayon industry began to give it serious attention in the competitive situation that developed since the big crash. The rayon industry has also been giving some attention to recovery of chemicals, but the one really important field for recovery which had not been tapped in 1929, i.e., caustic soda recovery in the viscose process, is still largely experimental in this country.

Among the pigments, perhaps the rise of titanium dioxide has been the leading development. National Lead's enterprising subsidiary, Titanium Pigment Corp. pioneered the development in this country prior to the depression, but the broadcast application has come in recent years. Commercial Pigments Co. of Baltimore, now owned by Commercial Solvents and duPont, had its start in 1928. The Vanadium Corp. entered the field in 1932 with the plant of the Southern Mineral Products Corp., Piney River, Va., but its output to date has not been large. Calcium base "high strength" lithopone has proved a depression pigment because its popularity has depended to some extent upon giving high hiding power at a relatively low price. A new antimony oxide pigment of high hiding power has received much interest in recent months. St. Joseph Lead's new process for producing zinc oxide directly from zinc-bearing ores has been a distinct departure from existing methods and one effected during the depression. Tung oil production in Florida and the other Gulf Coast States was started a good many years ago, but tank-car shipments have been made only during the past few months.

Space is not available to recount here the extremely important achievements among the metals. Materials of construction are treated elsewhere in this issue. (See p. 272), but the stainless steels, nickel-clad steel and the so-called ply metals, the Robertson bonded metals, developed at Mellon Institute, metallic magnesium, tantalum, beryllium-copper alloy, deplated and colored aluminum—all have become important since the depression started.

Rubber—Natural and Synthetic

With the price of crude rubber bouncing down the backstairs to unprecedented levels, one would scarcely think the depression a particularly auspicious time to launch a new synthetic process. Yet the announcement last year, of duPont's achievement in synthesizing DuPrene, a new rubber-like plastic, met with wide interest and almost immediate application in chemical engineering industries. DuPrene is polymerized chloroprene, prepared from acetylene and cuprous and ammonium chlorides. Because it is resistant to oils and solvents that swell and attack rubber, DuPrene has proved most useful in gaskets, packings, valve diaphragms and similar uses.

A joint product of the reaction is a spontaneously polymerizable synthetic drying oil known, for short, as S.D.O. It promises to become an important acid-resisting coating for metal, wood and concrete. Thiokol, synthesized by polymerizing ethylene dichloride with sodium polysulphide, is another new rubber-like compound of recent origin. It behaves like rubber in many of its properties but it also resists oils and solvents and has for this reason found important uses in fields that rubber could not serve.

What about the rubber industry itself? Has it been asleep these past three years? Most certainly not. It made many advances in its own technology, such as the more effective use of anti-oxidants and new accelerators. Goodrich has contributed such important chemical engineering developments as the Vulcalock process for bonding rubber to wood and metal which opened up a vast field of utility in lining equipment. The anodic process for depositing rubber electrolytically is another development in which Goodrich has had a hand. Both of these were announced prior to 1930 but their practical commercial development has come since the depression. The rubber plastic, Plioform, announced by Goodyear in recent months, cannot only be molded but used in protective coating and for impregnating fabric and paper.

This records, in all too sketchy a way, the many advances made by chemical engineering during the four-year war against the depression. News is reported here from only a few of many battle fronts. The record is the more impressive because these advances are still in progress. Other bulletins will appear in subsequent issues. Chemical engineering marches on!

BUILDING AN INTEGRATED INDUSTRY IN

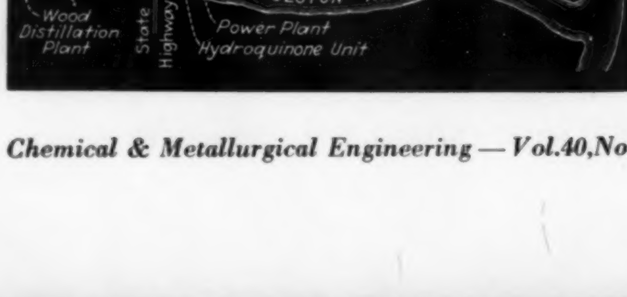
Tennessee Eastman goes ahead with its long-time program. Hardwood distillation becomes, via cellulose acetate, the basis for a diversified process industry, producing, in addition to safety film, acetate yarn, plastics, lacquers, laminating stock for safety glass and transparent wrapping materials.

WHEN THE DEPRESSION struck terror in Wall St. in the Fall of 1929, and later necessitated certain adjustments and readjustments in nearly every industry, the Eastman Kodak Co. like most other companies, had laid its plans for a logical growth and development. In Kingsport, Tenn., for example, it owned through its subsidiary, the Tennessee Eastman Corp., a large wood distillation plant which it operated in connection with a sawmill and some 40,000 acres of timber. Among other products, the plant produced methanol and acetone for film manufacture. But the management, both in Kingsport and Rochester, could foresee a much greater development from these basic raw materials.

For nearly twenty years the company had been making cellulose acetate film in its chemical plant at Rochester in addition to the more generally used cellulose nitrate film. At first this was on a relatively small scale but when the Ciné-Kodak began to popularize the home movie after 1923, the demand for safety film increased proportionately. Likewise, during the past decade an increasing proportion of x-ray film has been produced of safety materials. Gradually it became apparent that Tennessee Eastman with its strategic chemicals and nearby source of cotton linters, was the logical center for the manufacture of cellulose acetate for use in film making at Rochester. A bold program of expansion was already on paper and back of it were not only the years of experience gained as the country's oldest manufacturer of cellulose acetate but also a great accumulation of the results of chemical and chemical engineering research—only waiting to be translated into new forms of industrial activity. What to do?

The decision was squarely up to the management at Rochester. Be it said to their credit that the executives voted to go ahead—even in the face of the depression. Construction work on the first unit of development, already under way, was rapidly advanced, and early in 1930 the cellulose acetate plant went into production. Later in the same year a new hydroquinone project was completed. In October, 1931, an acetate yarn plant (on which the experimental work began in 1928) was put into operation and shortly proved so successful that it was necessary to arrange for increased production of yarn, together with more cellulose acetate. Therefore, work was started in 1932 on additional equipment to enlarge the capacity of the yarn plant; also large increases in the cellulose acetate and acid recovery units; and further, a new plant for the manufacture of a non-hazardous plastic material called Tenite, two units for which were put in production early in the present year. Along with all of this growth a new research laboratory, a new power plant and water filter station, and other vital facilities and accessories of production were rapidly being completed. The number of permanent employees had been increased by 150 per cent, and at times in addition as many as 500 men were employed in construction

Plant property of the Tennessee Eastman Corp. at Kingsport covers 375 acres



TIMES OF

DEPRESSION

By SIDNEY D. KIRKPATRICK
Editor of *Chem. & Met.*

Opening up the bales of cotton linters and feeding them into the tunnel dryer

work. With the completion of this entire program Tennessee Eastman has a productive capacity of cellulose acetate probably not exceeded by any other plant in the United States and perhaps in the world.

The cellulose acetate plant is so dependent upon the older wood distillation unit that any description of its operation must begin with at least a brief reference to this source of important chemical raw material. Since this plant was last described in *Chem. & Met.* in November, 1929, the calcium acetate unit has been replaced by modern facilities for producing sodium acetate and acetic anhydride. The crude pyroligneous acid is neutralized with soda ash, evaporated first in a triple-effect and then in a single-effect Zaremba evaporator. The crude sodium acetate is discharged on Buflovak rotary drum dryers and then purified by a high temperature process in which the sodium formate and tarry materials are removed by carbonization. Accurate temperature control is maintained by the use of an indirect heating medium employing a modification of the Merrill process.

After the sodium acetate has cooled, it is transported in closed lorry cars to the reactors where sulphur chloride is added in sufficient quantity to produce the acetic anhydride. A residue of salt, sulphur and carbon is left after the anhydride is distilled off which is then chemically treated and further refined by distillation. After this stage of the process, steel equipment cannot be used since even traces of iron would contaminate the cellulose acetate sufficiently to render it useless for either film or yarn. Accordingly, the newer acid resistant materials of construction are used exclusively in the cellulose acetate plant.

The quality of the other chief raw material, cotton linters, is guarded just as zealously. Eastman has been a purchaser of this commodity for more than thirty years during which time its laboratories have developed the

The new acetate yarn plant operates night and day. Its annual capacity since recent enlargement is approximately 3,500,000 lb.

most rigid specifications. The carefully wrapped bales of linters are opened and shredded into Proctor & Schwartz tunnel dryers as shown in the accompanying illustration. The dried linters are then charged by hand into the large acetylators where they are acted upon in the presence of a catalyst by acetic anhydride and acetic acid. Conditions of concentration and temperature are carefully controlled, but varied to meet the requirements for the different types of cellulose acetate which in turn depend upon the particular purpose for which it is to be used. When the solution has reached the desired viscosity, the acetylator's content of cellulose acetate is discharged into large acid-resistant vessels in which the ripening or hydrolysis of the product occurs.

One of the many operations in the textile department: Spooling the acetate yarn

Precipitation of the cellulose acetate, the next step in the process, is effected by the addition of water. Then the excess acetic acid and the catalyst must be removed by extended washings in large circular tanks provided with mechanical agitators. The wet product is then dewatered and dried. The finished product, removed from the dryer into an overhead hopper, is pressed into 50 lb. cakes or bales and carefully wrapped and packed in strong paper cartons for shipment to Rochester for use in film or Kodapak or for transfer to the yarn or plastic plants at Kingsport or for sale to the trade. The pressing equipment is shown in one of the views on the opposite page.

Recovery of the acetic acid from the dilute liquors is a most important step in the cellulose acetate process. In fact, the acid recovery building, as will be observed from one of the general views of the plant, is the tallest structure of the group. It houses some of the largest copper fractionating equipment used in any industry. The acid is recovered as glacial acetic of desired strength and purity for re-use in the acetylation process.

Eastman's acetate yarn is manufactured in a group of buildings 100 ft. wide and approximately 800 ft. long, lying to the south of the cellulose acetate plant and paralleling the Holston River. At the north end, there is a 4-story section of fireproof construction in which the cellulose acetate is dissolved, and prepared for spinning. Next is a 3-story section in which the spinning machines are housed while the remainder of the building is devoted to the textile and packing operations and is of one-story, mill type of construction.

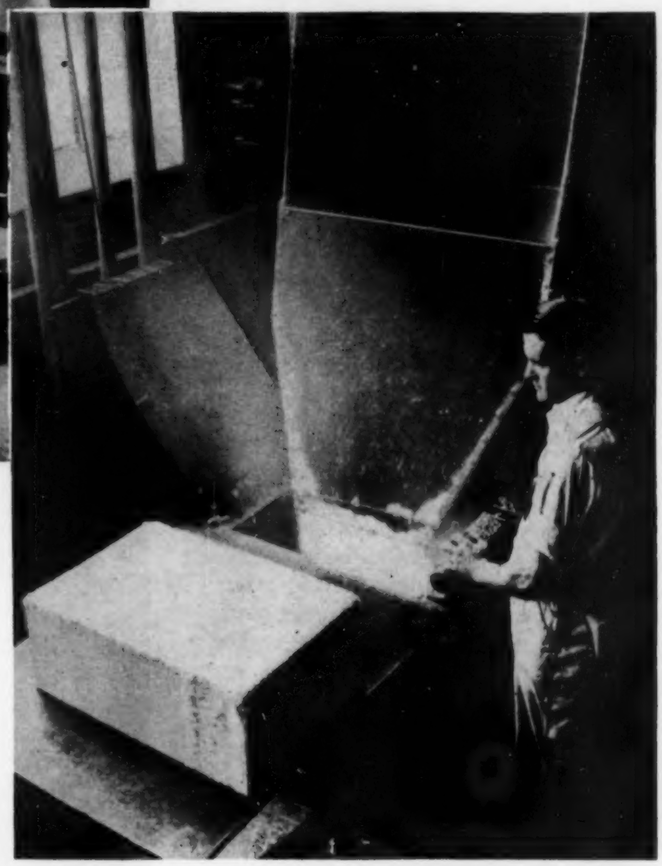
A complete system of air conditioning for maintaining uniform temperature and humidity was installed by the York Ice Machinery Corp. Three air conditioning units were required, one for the spinning building and two for the textile department. An interesting and related feature of construction is the flat roof over the entire building, so designed in order that it may be completely covered with water to assist in the cooling during hot weather.

The cellulose acetate is received in cars from the acetate plant and transferred to the fourth floor of the yarn building. The bales are broken apart by hand and the acetate is dropped through chutes to the dissolvers on the third floor. A measured quantity of acetone is added

Wood distillation units that supply the chemical raw materials for cellulose acetate manufacture

Charging a drum of purified cotton linters into the acetylating equipment

Pressing a cake of finished cellulose acetate which is to be wrapped in paper for shipment as raw material for safety film, acetate yarn, plastics or transparent wrappings



simultaneously and the solution mixed to give the spinning solution of desired viscosity and uniformity. This solution is pumped to storage tanks and then forced under pressure through filter presses. The filtered solution is pumped to supply tanks in the spinning building. Here it is carried by small gear pumps to the spinnerets and is extruded to form the filaments, which gathered together, form the yarn. To obtain uniform high quality, all conditions must be kept as nearly constant as is humanly possible. At Kingsport, these essential practices include the proper blending of the solutions and the mechanical and chemical control which were developed and carefully standardized during the three years of experimental and semi-commercial operations.

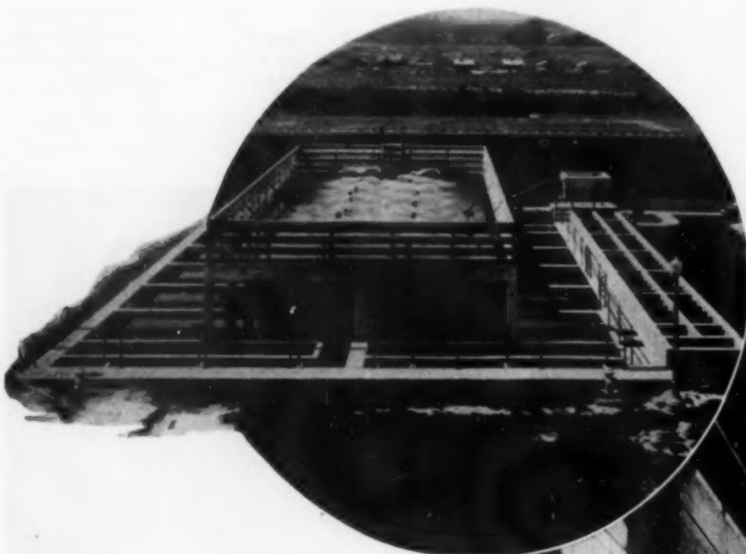
Subsequent to the spinning, the yarn passes to the textile department where the usual series of twisting, coning, and spooling operations are carried out. The output of the yarn plant, which has a capacity of 3,500,000 lb. annually, is sold through A. M. Tenney Associates, Inc., of New York City.

Cellulose acetate also lends itself admirably to the manufacture of plastics and toward the end of 1930, the Tennessee Eastman Corp. commenced development work on the molding composition that has since been introduced under the trade name of Tenite. The semi-plant scale unit was constructed late in 1931 and as the demand rapidly increased, construction was pushed forward and at the beginning of the present year, two new manufacturing buildings were completed and put into production. The many desirable properties of cellulose acetate as a molding compound include its toughness, strength and resiliency, and the fact that it can be prepared in clear, pastel shades or entirely transparent if desired. Most im-

portant, perhaps, is the fact that it is slow burning. The Underwriters Laboratories reported Jan. 27, 1933, as follows:

"Hazards of this product in use are judged to be small and in storage somewhat less than would be presented by common newsprint paper in the same form and quantity."

In addition to Tenite in slab and granular form, the corporation supplies the plastics industry with raw cellulose acetate and with cellulose acetate pastes and powders. The diversity of products molded from this material is represented by such different applications as combs, switch keys, toothbrush handles, automobile hardware and safety goggles.



Water purification unit showing filter station and spray pond for aeration

A special acetate of high clarity and the desired properties for the manufacture of laminating material for safety glass is also produced in large quantities. This is being widely used by the automobile industry.

An account of this expansion program would be incomplete without at least a brief reference to the new power plant, filter station and water softening unit put into operation early in 1931. Three new stoker-fired boilers operate a 1,500-kw. non-condensing turbine-generator and one of 3,000 kw. in the new plant, and a 500 kw. generator in the old plant. An interesting description of the power plant and process steam distribution system appears in the Feb. 3, 1931, issue of *Power*.

Pure water is an essential consideration in a plant of this kind. Accordingly some 2,500,000 gal. of water are pumped daily from the Holston River, aerated to remove the dissolved iron, filtered, and that which is used in the boilers is continuously softened by an automatic lime-soda softener.

From the foregoing it is apparent that the Tennessee Eastman Corp. taking advantage of conditions generally considered handicaps, has gone steadily on in the depression period with its program to build a logically coordinated and integrated industry. Its expansion has not been haphazard or purely opportunistic. Rather it has been a part of a carefully planned program for broadening the base of the Eastman structure through chemical research and chemical engineering development of its raw material resources. It has entered new fields—but only those that were logically related to its existing activities. It has not attempted to force its markets but instead, has tried to contribute constructively to each consuming industry. A real measure of progress has already been made, and fortunately, there is still an abundance of opportunity ahead. Cellulose acetate has a promising future in a wide range of industries.

View in the new power plant: Note the absence of a division wall between the boiler and turbine rooms

Editor's Note.—**Is this a depression achievement? Here's the record. Judge for yourself. During the past three years, according to its president, C. P. Gulick, National Oil Products Co. has had no pay-cuts or lay-offs, has increased its forces by about 33 per cent, and its sales volume has grown proportionately. Net income increased 15 per cent in 1932. During the past few years over $1,000,000 has been spent in enlarging plant facilities at Harrison, N. J. Research, says Mr. Gulick, has been the key to the whole expansion program.**

RESEARCH CREATES NEW MARKETS FOR SULPHONATED OILS

By RALPH WECHSLER
Technical Director
National Oil Products Co., Harrison, N. J.

A LITTLE OVER 25 years ago in 1907, when National Oil Products Co. was organized to produce animal and vegetable oils and their derivative products, the number of sulphonated oils in general use was very limited. Today, due largely to the research work conducted in the laboratories of this company, sulphonated oil products are numbered by the thousand, they are used for a great variety of purposes, in many industries.

The first oil to be sulphonated for technical use was olive oil. A patent for making this oil was granted to John Mercer, of England, in 1846 and thereafter it was employed to a limited extent for imparting an added brilliancy to turkey-red and alizarin-red dyes for textiles. Some 30 years later, sulphonated castor oil was found to be better and cheaper for this purpose, and, under a variety of names, but chiefly as turkey-red oil, it became widely used by the textile industry.

National Oil Products Co. began operations as the successor to the business of a turkey-red oil manufacturer. The organizers of the company saw in the peculiar properties of the sulphonated oils many promising possibilities, and instituted a program of research with the objective of extending their applications. This program embraced: (a) A study of the various industrial processes to determine where sulphonated oils might profitably be used. (b) Addition to the number of available sulphonated oils, with a diversity of properties, by sulphonating all animal and vegetable oils obtainable in commercial quantities; by varying the product by varying the method of manufacture; and by combining sulphonated oils with each other and with untreated animal, vegetable, and mineral oils and waxes.

The result of this work was a rapid extension of the use of sulphonated oils in the textile and tanning industries, and their introduction into many other new fields such as metal working, laundries, and the manufacture of glue, paper, cosmetics, paints and varnishes, ink, polishes, agricultural sprays, and disinfectants. Among the developments of special technical and commercial importance for which the company was responsible can be mentioned the introduction of sulphonated cod oil into the tanning industry, the discovery of an improved base for metal cutting oils, the substitution of special sulphonated oils for soap and oil emulsions in soaking raw silks, the extension of the application of sulphonated olive oils for silk finishing, and the development of a method of preventing rancidity in oils.

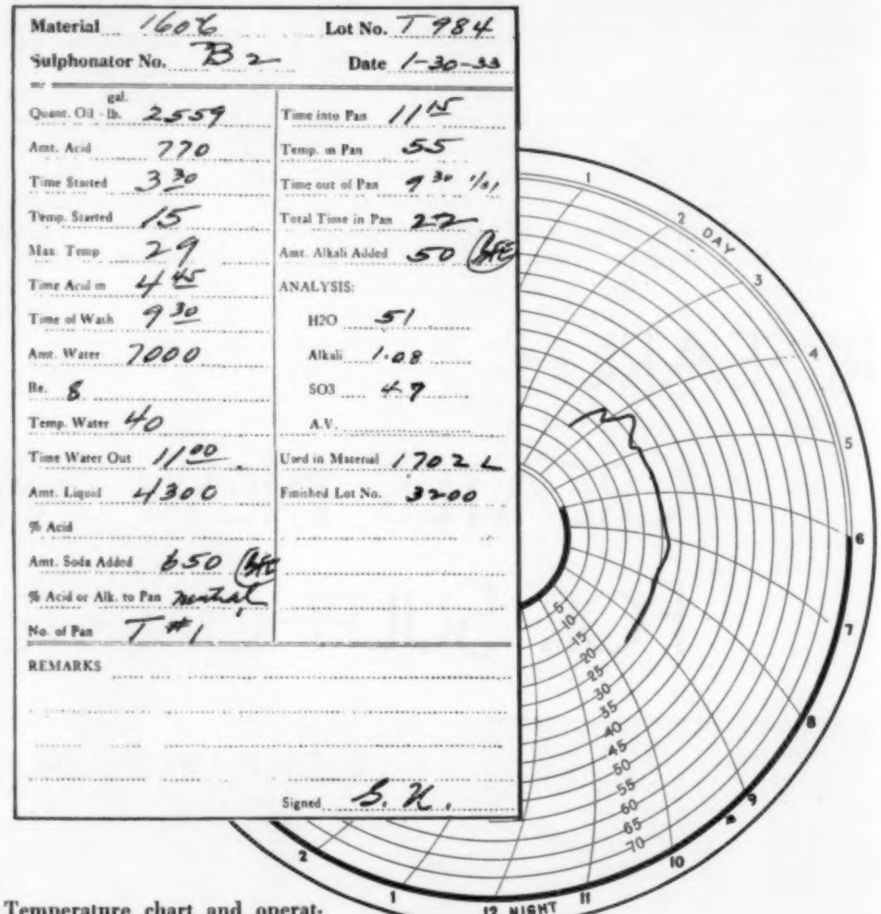
An allied line, in which a subsidiary of the company is engaged, is the manufacture of insoluble metallic soaps. This work started with the production of a special aluminum palmitate for waterproofing stucco. Soaps of zinc, calcium, lead, copper, and other metals are now being made for use in the manufacture of paints and varnishes, lubricating bases, drugs and cosmetics, rubber, cordage, preservatives, and for wire drawing.

An interesting extension of the company's business into a very different field resulted from the discovery by McCollum and others of the vitamin *D* content of

cod liver oil and the part this vitamin plays in the building of the bony structure in human beings and animals. Advantage of these facts was taken to develop an extensive business in the sale of cod liver oil for poultry feeding. Later, arrangements were made whereby the Zucker process of concentrating the vitamin *D* content of cod liver oil could be employed. This made it possible to supply oils highly potent in vitamin *D* to poultry raisers and manufacturers of poultry feeds, and also to produce a vitamin *D* concentrate suitable for enhancing the nutritive value of milk and bread for human consumption.

A practical test of the true value of animal and vegetable oils and their products to industry and of an active policy of continuous research has come during the past three years when the diversified use of the company's products and the ability to meet promptly and effectively all new requirements have resulted in expanding operations throughout the whole period of the depression.

The process of manufacturing sulphonated oils can be stated very simply. Oils or fats containing unsaturated acids or hydroxyl groups are subjected to the action of strong sulphuric acid. The reaction consists in the formation of esters by addition of sulphuric acid at the double bond. For oleic acid found in many fats and oils the following reaction is typical:



Temperature chart and operating data for sulphonator

$CH_3 - (CH_2)_7 - CH = CH - (CH_2)_7 - COOH + H_2SO_4 = CH_3 - (CH_2)_7 - CH_2 - O\text{-}SO_3H - CH - (CH_2)_7 - COOH$

The resulting product is then washed and neutralized with caustic soda or ammonia.

In actual practice, however, the process is by no means simple. During the course of manufacture, any of the following major reactions may take place:

Hydrolysis of the glyceride; polymerization; addition of the sulphonic group at various points in the chain; hydrolysis of the sulphonated products during washing with the splitting off of sulphuric acid and the formation of hydroxyl compounds, lacteons, esters, and similar products.

In consequence, a sulphonated oil as manufactured commercially is not a definite chemical compound but a complex mixture, and only by exercise of rigid control of every step of the process are uniform products attained. Conversely, by varying these conditions, products having a wide range of properties may be obtained from the same raw materials.

The principal points of control are as follows: Concentration of the acid; ratio of acid to oil; time required to add acid to oil; temperature of reaction during the addition of the acid; time allotted for the reaction between the oil and acid prior to washing and the temperature during that period; nature of the washing medium—whether plain water, sodium sulphate solution, or sodium chloride solution; temperature of the washing medium; time of contact and degree of agitation in washing; pH of washing medium; degree of separation before neutralization.

In practice, all of these details are carefully worked out for each product to guide the manufacturing department. During each process, a "flowsheet" is filled out giving significant data at each step so that the exact details in respect to each lot can be checked.

The equipment employed is of simple description, including, in addition to storage and pumping facilities, tanks in which the oil and acid are mixed, a tank into which the treated oil is run for washing and neutralizing, and a series of pans in which the neutralized oil is allowed to stand for the completion of the process. Steam coils and cooling coils provide means for controlling the temperature at various stages.

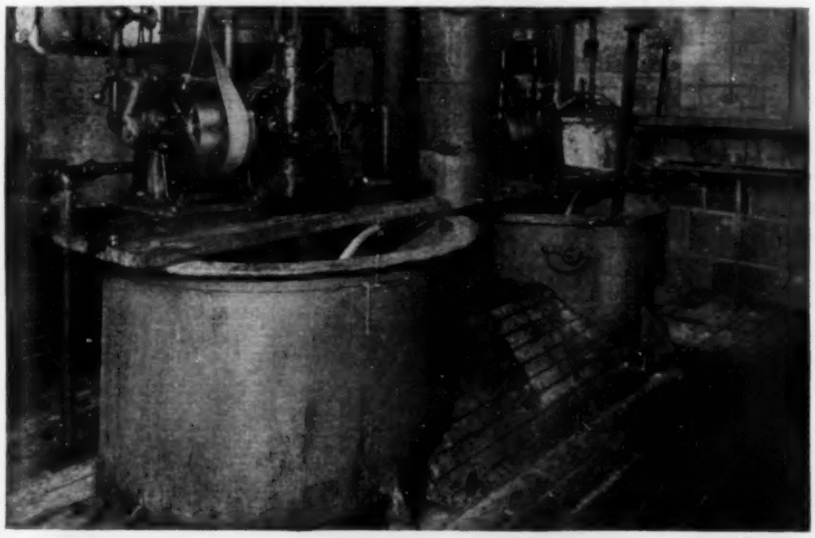
The accompanying temperature record illustrates the temperature control of the mixing process. The operator, in this case, was instructed to keep the maximum temperature below 30 deg. and to maintain the mixture at a constant temperature of 25 deg. after the initial temperature rise had subsided. The chart shows that he added the acid slowly for 15 min.; fearing that the rise might become too great to be controlled within the set limits, he then shut off the acid temporarily. After waiting for another quarter of an hour, he became satisfied that he had the situation under control and added the rest of the acid. From then on, he kept the tem-

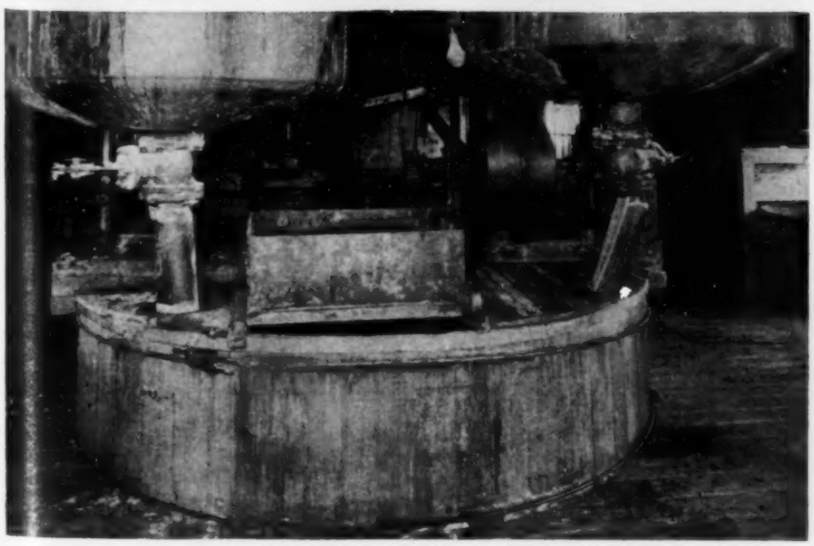
perature closely at the specified 25 deg. Only by careful attention to every detail, in the manner outlined, can satisfactory sulphonated oils be produced.

Sulphonated oils are undoubtedly "oils" as that word is used in common parlance. They possess the appearance, viscidity, and unctuous feel of untreated oils, and also their lubricating and softening powers. But they also possess an additional valuable property—they are miscible with water. This property can be easily demonstrated by shaking a small amount of a sulphonated oil in a test tube. Whereas a raw oil so treated would quickly separate from the water on standing, the sulphonated oil forms a stable emulsion. In such emulsions, the oil is dispersed into small particles, almost approaching molecular proportions. Emulsions of certain oils, in fact, can hardly be distinguished from solutions.

Sulphonated oils lower the surface tension of the water to which they are added; the emulsions formed are stable in the presence of dilute acids and calcium and magnesium salts; and they are excellent emulsifiers of all kinds of oils, fats, greases, and waxes. Because of these properties, sulphonated oils have a large number of different applications. They can be used as lubricants and softeners, and yet can be easily washed away. They penetrate porous surfaces more readily than raw oils and can impart this property to other oils. As detergents, they are in many ways superior to soap solutions, especially in the presence of acids or where hard water must be used. When employed in the manufacture of compounds containing oils or fats, they often permit the substitution of water for alcohol, either completely or in large part, thus reducing the cost of manufacture.

The textile industry is a large consumer of sulphonated oils. Their emulsive properties make them useful in all manner of scouring operations. They are employed for lubricating fibers and yarns in carding, spinning, weaving, and knitting operations. When added to dye baths, they provide better dye dispersion, penetration, and "wetting out," and therefore insure more uniform dyeing. They are also used for soaking raw silk, to render the sericin more pliable during winding, reeling, twisting, and similar operations and for removing the sericin after the silk has been thrown or woven. In finishing, they impart softness to the cloth, giving it what is known as a "good hand."



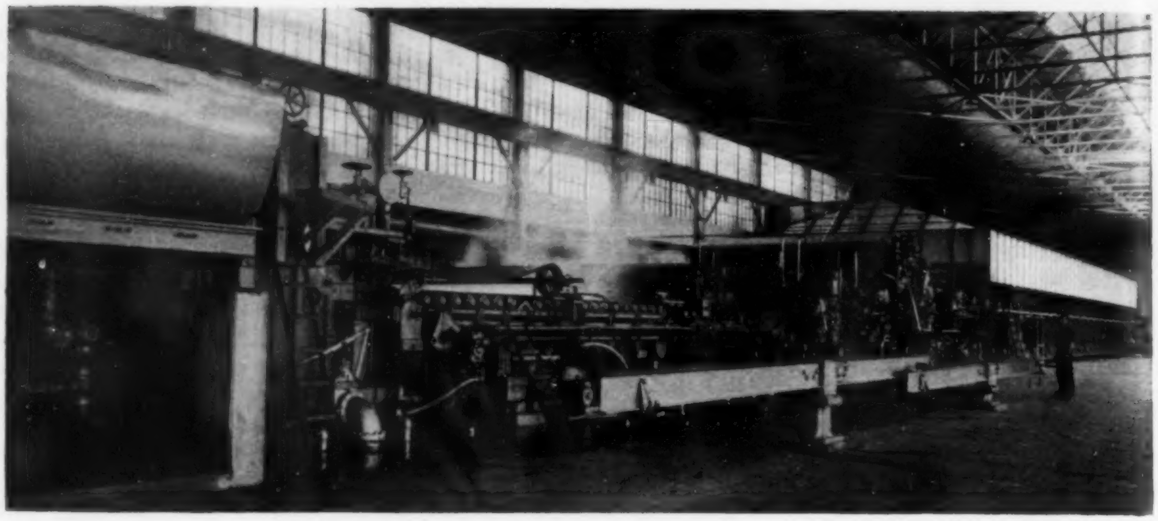


Above—Mixing tanks with acid and oil storage
Below—Two sulphonators discharging into single wash tank

The penetrative qualities and the low surface tension of sulphonated-oil emulsions are particularly valuable in tanning. In the "fat liquoring" process, raw oils and sulphonated oils are emulsified in water and applied to the leather in a revolving drum. The sulphonated oils carry, or "drive," the raw oils into the fibrous structure of the leather, thus lubricating the fibers and making the leather pliable. These oils are also used in connection with the dyeing of leather.

In the cosmetic industry, the softening and emulsifying properties of sulphonated oils make them useful in brushless shaving creams, hand lotions, cold creams, cleansing creams, soapless shampoos, and similar products.

Sulphonated oils are used as defoaming agents by the glue and paper industries, as detergents by laundries, as lubricants in wire-drawing, as cutting and buffing compounds in metal working, to increase the oil absorption and spreading qualities of printing inks, as carriers of disinfectants and agricultural sprays, for making water-soluble perfumes, for furniture and automobile polishes, and for a variety of other purposes. This list is constantly being extended; apparently no limit exists to the applications of these oils, and experience shows that when applied to solve some special problem in a new industry, other and unsuspected uses in the same industry are frequently discovered.

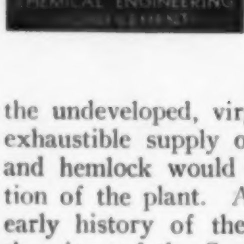


New 242 in. paper machine viewed from the wet end

CHAMPION FIBRE Adapts Itself To CHANGING CONDITIONS

By HAROLD R. MURDOCK

Director of Research Department
Champion Fibre Co., Canton, N. C.



IN 1906 THE LATE Peter G. Thomson erected at Canton, N. C., a pulp mill to supply pulp requirements for his paper mill at Hamilton, Ohio. He did not choose this location because the mountains of western North Carolina are one of the beautiful spots in the eastern United States, neither was he attracted by the numerous mineral resources contained in those mountains. He realized that the undeveloped, virgin forests provided an almost inexhaustible supply of hardwoods, and that the spruce and hemlock would serve as a bulwark in the operation of the plant. A review of the files as well as the early history of the Champion Fibre Co. shows that the pines of the South also held his attention as a raw material.

It is interesting to compare this earlier plant with the complete pulp and paper plant now operating at Canton, which, through the period of depressed business activity has maintained its leadership. Canton was then an obscure, inaccessible community of few inhabitants. It is now the second largest city in western North Carolina. The plant, at first concerned with manufacturing chestnut extract, soda and sulphite pulps, is now unique in that it is producing pulp by all of the four standard processes common to the industry, namely, soda, sulphite, sulphate, and groundwood. All of these processes in simultaneous operation and interconnected at common points merge with many other associate processings. At present the company is producing per day 350 tons of pulp, 200 of paper, 100 of chestnut extract, 25 of caustic soda, 60 of lime bleach, 20 of adhesive extract, 10 of rosin soap, and 300 gal. of turpentine from the pulping of pine wood, and many other byproducts derived from its complex merger of chemical processings.

When this company entered the era of worldwide depression it realized that it would have to adapt itself to the changing conditions, and laid down a definite program. There is scarcely a step in any process which has escaped this campaign for improvement. Some of these improvements would not be apparent, even to the practiced eye of one familiar with the technique of the industry, while others are so apparent that they would arrest the attention of even the uninitiated.

While the company maintains an active and well-equipped research department, this is but a small part of the research activities. Literally, everybody in the mill is a research worker, and by a well-planned policy of education of its employees in analyzing and reporting operations which appear to be capable of improvement, this company has made strong inroads into its costs of 1929, which were in those days relatively satisfactory. During these trying days this organization of 1,500 men has been able to maintain its productiveness with little if any curtailment, and it is probably more because of this loyalty to research activity by all of its personnel that such a status has been possible.

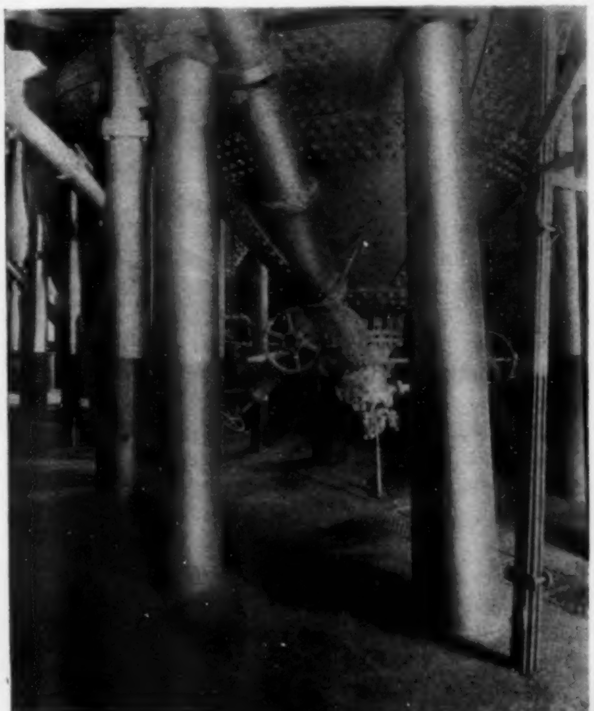
A review of some of the recent improvements will be of interest:

When the depression first became apparent, the plant was completing the installation of two Heine type boilers, which have a steam generating capacity of 10,000 hp. each. These boilers, burning 600 tons of powdered coal per day, at over 88 per cent efficiency, have placed the company in an enviable position with respect to cost of steam generation. Steam is generated at a pressure of 450 lb. and passed to Westinghouse, bleeder-type steam turbines, working at a bleeder pressure of 125 lb. and a back pressure of 25 lb. The 125-lb. steam is used as heat in the operation of the digesters, as power in operating the engines supplying the paper machines, in operating the engines producing direct current in the electrolytic bleach plant, and in many other operations, while the 25-lb. process steam has a multiple number of uses throughout the mill, particularly in the drying of paper and pulp at the machines, in heating of water for extracting chestnut chips to obtain chestnut extract, and the like. Besides the steam generated in the main boiler plant, there is also a substantial amount obtained from modern waste-heat boilers which have been installed recently in the chemical recovery plants. The steam from these units is fed directly to the main system. It has been recognized that the company is operating one of the most efficient byproduct steam plants in the country.

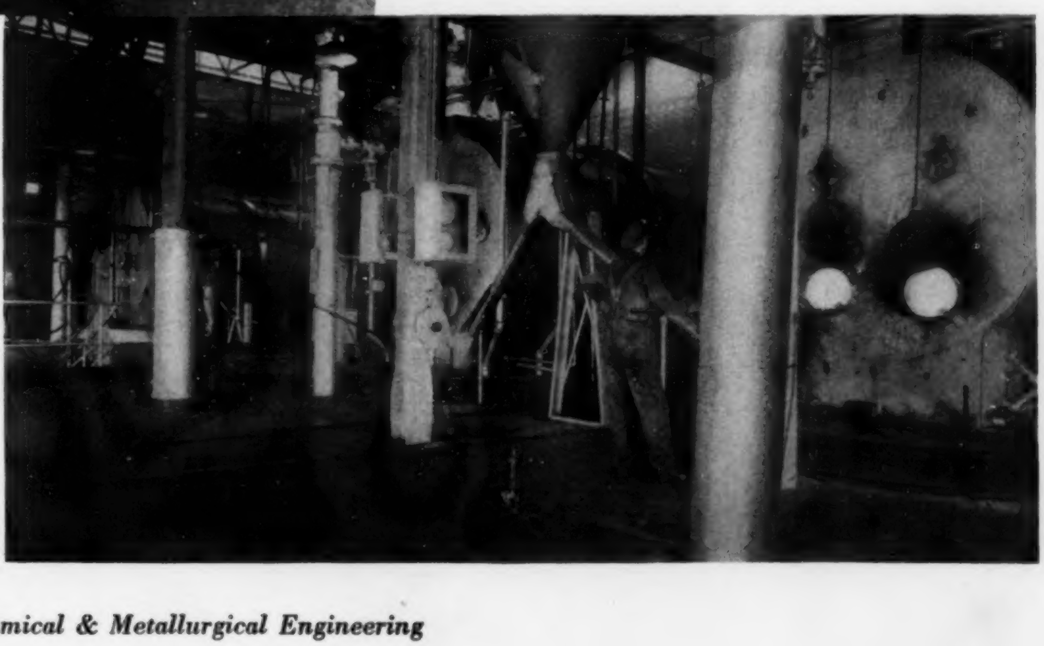
In 1921 it became apparent that the future of the plant depended to a considerable extent upon its ability to convert its pulp into paper. A pulp mill, operating without a paper machine, of necessity is obliged to dry its pulp for shipment. Obviously, therefore, it would be more economic if the pulp were converted into paper with no drying process until it reaches the paper machine. It was for this reason, therefore, that the first paper machine was installed in 1921, with a fourdrinier wire width of 168 in. A similar machine was added in 1924, and the company then became a factor, not only in the pulp industry, but in the paper industry. But, this was not enough to insure a continuation of its pulp mill activity, and with this in mind together with the desire to assist in the relief of the unemployment situation, plans for the installation of the largest fine-paper machine in the world were started in 1931.

This machine is one of the most complete and modern paper machines in all of its details ever erected. The belt and pulley drive, common to the usual paper machine, has been eliminated by driving the entire machine with sectionalized d.c. motors, power for which is developed by a motor generator set driven by a synchronous motor. A rather intricate Selsyn, all-electric control system takes care of uniformity in speed of the various sections, in respect to one another. Although the mass of relays, switches, and the like, may appear to the casual observer as extremely complicated, it is really this part of the equipment which makes the operation of the machine so simple and easy to the operator.

It was necessary to erect three separate buildings, adjacent to the then existing buildings, which would cover



The sulphite digesters showing blow lines and liquor and steam inlets



A view of the operating floor of the sulphate recovery plant, showing the connection between the smelter and rotary incinerator

a ground area of 66,300 sq.ft. and afford a total working floor space of 157,700 sq.ft. Only 146 days elapsed from the day that ground was broken for the erection of these buildings to the day when the paper was actually made on this new paper machine. This is believed to be a record for installation of a paper machine approaching this one in size. The machine was started on March 25, 1932, and within a few hours paper of commercial value was being produced.

Construction of New Paper Machine

Some of the details in the construction of this new machine are of particular interest. The wet end of the machine carries a fourdrinier wire 85 ft. in length and 242 in. in width and is equipped with a 36-in. diam. suction couch roll with cantilever attachment. It carries seven flat suction boxes with motor-driven oscillating device, twenty 10-in. table rolls, a 26-in. diam. breast roll, and a removable type wire handling arrangement, so that a new wire can be installed within one hour. The slushed pulp comes onto the wire through an improved Voith flow box.

Besides smoothing rolls, the machine has three sets of press rolls, the lower of each set is a 32-in. diam. rubber-covered roll and the upper a 28-in. diam. stone roll. The smoothing roll is mounted at the drying frame so that the paper, when it leaves the third press, can, if desired, be passed through the smoothing rolls to remove any wire or felt marks before it passes on to the dryer.

The dryers consist of forty 60-in. diam. steam-heated cylinders, while the four dryer felts require six 40-in. diam. dryers. All dryers are mounted on antifriction bearings and are lubricated with a gravity feed system. The entire dryer part of the machine is hooded with a panel-type Transite board with exhaust fan leading to the atmosphere. This was designed with particular attention to the simultaneous heating and ventilation of the building.

The machine was constructed to operate at a minimum speed of 75 ft. per min. and a maximum speed of 1,050 ft. per min., such extremes being possible only by means of the synchronous motor sectional drive.

There are two stacks of calenders, one containing seven and the other nine rolls, the bottom rolls, which is the largest in each stack, is 34 in. in diameter and weighs approximately 67,000 lb.

As a continuation of the extended program to convert more of the pulp into paper, the company has just started operating its second board machine. Because of converting more pulp, the load on the pulp dryer machine necessarily became diminished so that it was possible to convert one of the original drying machines to a board machine. It required extensive alterations, as the dryer section was the only part of the pulp-drying machine which could be utilized. The completed machine has five cylinders and two calender stacks with the usual stock chest to supply the vats with pulp. This machine has a capacity of producing board 125 in. wide and completes the program of the desired amount of pulp conversion.

The Champion Fibre Co. takes 30,000,000 gal. of water per day from the Pigeon River. Like all streams in mountainous sections, the rise and fall is subject to considerable fluctuation, and in order to insure a more even flow of water in the river at Canton it was considered economical from the point of purity of water and the cost of processing freshet water to impound a substantial amount above Canton and permit the reservoir to bleed to the stream in a regulated manner.

After a considerable study of the topographical and stream conditions above Canton, it was decided to build an impounding dam at Sunburst, a point on the west fork of the river, about 15 mi. from Canton, because at this point the mountains form a narrow gorge and permitted the collection of water draining from an area of 34 sq.mi. By controlling the release of water in this impounding basin, the dam has been able to give a more even flow to the water at Canton.

The dam, as constructed, is 50 ft. high and impounds 600,000,000 gal. of water. It has two spillways, the lower of which is 75 ft. long and the upper 360. Under normal conditions the 75-ft. spillway takes care of the stream flow. In order to drain the reservoir, a 36-in. pipe was located 3 ft. above the river bed and is opened and closed by a gate valve. In order to regulate the discharge there are four 16-in. lines, spaced 9 ft. apart at suitable levels, all of which connect to a 24-in. discharge pipe through butterfly valves. It is this drain which is normally used to maintain the requirements at Canton.

This dam permits a constant yield of 14,000,000 gal. of water per day. The design was calculated on the formula for a cylinder subject to a uniform external pressure of 25 tons per sq.ft. and based on a static head of 60 ft. In order to lessen the pressure on the foundation, the down-stream radius was made 6 ft. shorter than the up-stream radius, thus thickening the haunches 2 ft. The up-stream radius is 237.2 ft. and the down-stream radius is 231.2 ft., with an interior angle of 130 deg. It was built in voussoirs, each 32 ft. long and 5 ft. high. Copper water stops are in both the horizontal and vertical joints.

Every day over 100 cords of pine from Georgia and the Carolinas is converted into bleached pulp, mixed with other fibers and made into high-grade white paper. This company prefers to process all pines by the alkaline methods, particularly a modified sulphate process which it has developed by continuous research over the past ten years. The enviable position which is held in processing southern pine, was not attained by one masterly stroke. It is the result of prolonged research in the pulping, bleaching, efficient recovery of the cooking chemicals and the recovery and uses for the many by-products of the process.

Develops Unique Recovery Process

Probably one of the most outstanding steps, especially from the point of cost, is the patented process, which has only recently been installed, for recovering chemicals from the black liquor or spent liquors from the digestion process. This process possesses outstanding economies over the older Swedish methods and is believed to be more adaptable to the operation at Canton than the Wagner or Goodell methods, which have recently come into prominence. In brief, the recovery of chemicals consists in evaporating in multiple-effect evaporators to about 29 deg. Bé., the so-called black liquor, coming from the pulp at a density of about 9 deg. Bé., then passing this concentrated liquor countercurrently

to the gas, through disk evaporators, which are at the end of the several units in the recovery operation. This scrubs the waste gas going to the stack of the suspended sodium sulphate particles and reduces the temperature of the incoming gases from 600 to 230 deg. F. and at the same time further concentrates the liquor to about 40 deg. This concentrated liquor is now introduced into a rotary incinerator, where the liquor evaporates to a solid, ignites and falls from the lower end of the incinerator into the smelter as hot, carbonized lumps. The smelter acts as a reducing zone where the sodium sulphate is reduced to sodium sulphide and where the carbon content of the smelt is burned by a controlled amount of air introduced, as shown in the accompanying sketch. The smelt is run into a large tank of weak liquor, or water, to make what is known as green liquor, which is essentially a solution of sodium carbonate and sodium sulphide. The outstanding features of the process, as compared with the older Swedish method, are the patented connecting means between the smelter and the incinerator so that the heat of the gases and solids are not lost; the continuity of the operation, because of this design; the use of a waste-heat boiler to recover the heat from the gases; and the consequent lower temperature of the exit gases.

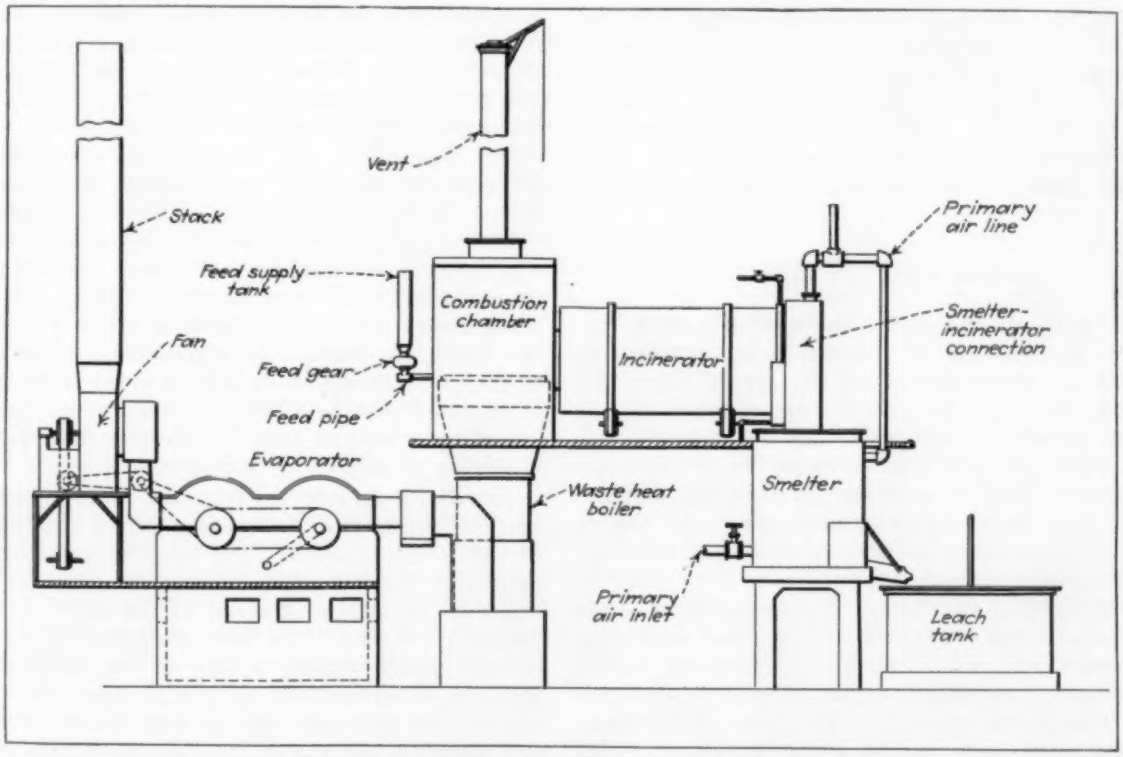
Other recent improvements, which space does not permit discussing in detail, are the washing of the pulp from the digesters free of cooking liquor in a continuous manner by use of rotary filters. Heretofore this was done by so-called diffusers or countercurrent washers.

The efficient recovery of chemical is not the only important factor in the operation of a sulphate plant on pine wood. The rational recovery of the byproducts is every bit as essential and is a very important part in the processing. When pulping pine by the alkaline processes, turpentine, dimethylsulphide and other volatile products are bled from the digester at optimum periods in the pulping process. The collected crude product is carefully fractionated by vacuum distillation in a separate plant for recovering byproducts. The still is a cylindrical kettle, 5 ft. in diameter and 9 ft. long, with a rectifying column 23 ft. 4 in. high, of twenty-one 20-in. diam. sections of the usual bubble cap design and with a 5-ft. dephlagmator.

Various fractions are taken, dependent upon the product desired, and the turpentine fractions further purified to remove the last vestige of sulphur and other undesirable constituents, so that the finished product is fully the equivalent of steam-distilled turpentine and for some uses even preferred. Dimethylsulphide is one of the newer babies coming from the process and has been sold as an odorant in natural gases and shows considerable promise as a raw material in the synthesis of some interesting industrial chemicals.

The recovery of so-called Talloel from the black liquor of this process is relatively old, but the continued efforts to ferret out applications for this byproduct have been of value in lowering the cost of pulp made by this process. Among the many uses found, probably the most recent one best illustrates the diversification of activities of the company. Research has shown that portions of this Talloel blended with suitable crude oils and sprayed upon coal makes it actually dustless.

Other points of research and developments in the pulp and paper industry could be mentioned. As this company passes the turn in the road to a new and bigger field in business activity, the road to the new era of American progress appears to be clear.



Schematic design of new unit for recovering chemicals from black liquor and those from digestion processes

A Plastic a Day Keeps Depression Away

BELIEVE it or not, there is at least one industry that is not "all hot and bothered" by the depression. In fact, plastic manufacturing owes much of its renewed vigor to the present poor state of business which has raised havoc with so many other industries. In the effort of many concerns to gain additional business they have turned to the plastics to supply the stimulant. This demand has spurred on the plastic manufacturers and has resulted in many improvements in existing products and in the development of "a plastic a day."

In recent years, Bakelite, the daddy of all synthetic resin plastics has made noteworthy progress. For years almost the entire production of this resin was used for electrical insulation and novelties. But today the trend is toward structural uses requiring greater quantities of the resin. Furniture and paneling for office partitions and for interior decoration are being made from this resin. Recognizing the growing demand from the process industries for corrosion-resisting materials of construction, the Haveg Corp. has put on the market resin-asbestos equipment, Haveg, of almost any size and design that promises to assist the chemical manufacturer in lowering his plant costs.

It has been found that cast phenolic resins, Catalin and Bakelite, may be made much lighter in color because of the lower temperatures and pressures that are required in their production. This lighter color has broadened the field of these resins. Likewise the use of phenolic resinoids in the paint, varnish, and lacquer industries has opened up a new field for them. Among the other well-known phenolic resinoids are Durez, Durite, and Resinox.

"Custom Made" Products

As Archie Weith has stated, the synthetic resin "industry has become one of 'custom-made' products in which special requirement is met by special properties in the material. In other words, the demands of the trade have exacted special materials for special uses, instead of one standard type of material for all uses. Thus materials have been developed that are flexible; materials that have marked superiority in impact strength, in electrical properties, and in water, alkali, acid and solvent resistance."

About the time of the "crash" in prosperity came the style for color in the housewife's kitchen and bathroom. The movement spurred on the use of synthetic resins, especially the urea-thiourea-formaldehyde type which was then new in this country. The color of the basic powders made by most producers is a pale ivory. This pale base color permits the production of an infinite variety of pastel shades which, together with the high refractive index of the resin, results in molded products of permanent beauty. For the production of drinking glasses, tableware, and the like the plastics, Beetle, Plaskon and Unyte, have the advantage over china and glassware of lightness and relative unbreakability.

Although the phenolic resinoids probably still lead the field in quantity consumed, recently the alkyd resins (Glyptal and Rezyl), that is, those resinous products obtained by the condensation of polyhydric alcohols with polybasic acids, have assumed increasing importance. It has been found possible to obtain permanently flexible resins in each of the three types of alkyd resins. This should extend the possibilities and uses of these resins.

The closely related vinyl and styrol resins are products of the depression, having only become of commercial importance during the past two years. The former has made rapid strides. Vinylite may be stamped into various forms, such as combs and toothbrush handles, and has put new life into the phonograph record industry. Its toughness and ease of molding are made use of in "long playing" sound records, in which the sound grooves are placed closer together than heretofore. It has also made possible a thinner record. Styrol resinoid, Victron, is of particular interest in the radio field due to its resistance to high-frequency voltage, which increases with increase in frequency, and to its excellent dielectric properties in general.

Plioform

Hard rubber has been used in large quantities for many years, but due to its opaque character this plastic has not been in a position to compete with the new transparent products. However, in December, 1932, the Goodyear Tire and Rubber Co. announced the development of an entirely new thermoplastic material which promises to open up many new markets for rubber. Plioform is available in transparent, translucent, and opaque forms. Besides being suitable for molding the new product has been used successfully for impregnating fabric and paper to produce laminated sheet. It is also suited for use in the manufacture of varnishes and lacquers and has been used already with considerable success in the production of a corrosion-resistant finish.

In the early days of the depression cellulose nitrate was introduced between two sheets of plate glass for the production of non-shatterable glass. As a sales point several automobile manufacturers at once offered the trade non-shatterable windshields. The popularity of this product spread rapidly to every make of car. It is expected that by 1935 this feature will be universal for already several state legislatures have passed laws requiring all cars to be thus equipped.

Search for an ester of cellulose, more light-stable and less flammable than the nitrate led to the development of the acetate plastics. Due to greater stability to sunlight this product has, during the past few months, replaced the nitrate in much of the safety glass manufactured for cars. An interesting development is that of wire cloth bearing a film of the cellulose acetate. Millions of square feet of this product are said annually to find their way into poultry houses, greenhouses, and hospitals because of its transparency to ultra-violet light. Due to its non-flammability it is rapidly replacing the nitrate in the production of combs, toys and other products.

SOAPLESS DETERGENTS

Point the Way to

NEW TREND in AN OLD INDUSTRY?

SOAPLESS detergents of a new type are to be developed in the United States under licenses to manufacture and sell the Gardinols. This group of compounds presents a variety of double sulphates of sodium and fatty alcohols manufactured under licenses of the American Hyalsol Corp., the U. S. owner of the patent rights of the German concerns which have controlled the original development abroad.

All of these sodium alkyl sulphates are made from various soap oils. By hydrogenation under high pressure and temperature with a copper catalyst the fatty acid molecule is reduced to the corresponding alcohol form, a departure from the usual hydrogenation procedure in fat hardening and the like in which additional hydrogen atoms become attached to the unsaturated molecules. Palmitic, stearic, oleic, lauric, and other major fatty acid molecules dominant in the fats are, of course, the principal types found in the resulting alcohol. These fatty alcohols are combined with sulphuric acid and soda to form a true sodium sulphate. Frequent commercial reference to them as sulphonates and sulphonated alcohols give an incorrect indication of their true chemical nature.

The original German development of these chemicals has taken place under a three-party agreement in which Deutsch Hydrierwerke A.-G., H. Th. Boehme A.-G. and the German I. G. are parties. American Hyalsol Corp. has purchased the United States patent rights of the two former companies after the granting of three licenses for the exploitation of the inventions in this country. One of these licenses is to the duPont organization for manufacturing and marketing in the industrial and textile specialty fields; the second to Procter & Gamble for household and laundry sales; and the third to a joint subsidiary of these two companies for general textile marketing in the name of the Gardinol Corp. National Aniline & Chemical Co. will also continue its American selling.

The major detergent advantage of the new compounds is claimed to result from the fact that the carboxyl radical is completely eliminated from the molecule, not merely suppressed as in sulphonated oils. Hence there remains no fatty acid to form insoluble lime or magnesium soaps, the common cause of scum formation with ordinary soap. The Gardinols, it is claimed, have exceedingly active emulsifying and cleansing action, lathering quite freely in hard waters. They have unusual penetrating power with resulting high wetting-out of textiles. Their neutral nature makes use practical in the presence of acids, alkalis, and other chemicals with

***Above*: Deutsche Hydrierwerke plant at Rodleben im Anhalt, Germany**

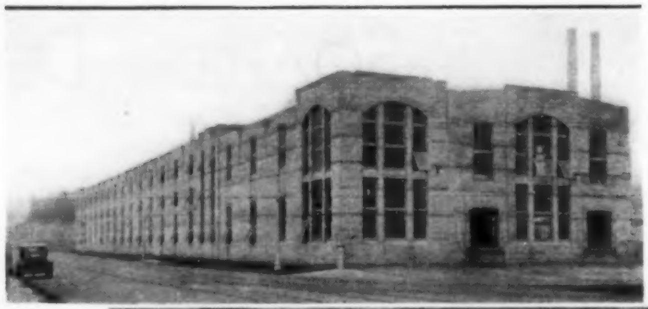
***Below*: Sulphonation autoclave seen in the interior of the Boehme plant in Chemnitz**

freedom from precipitation of insoluble soaps. The major claims made, of course, relate to general usage in hard water. But it is also said that in many cases with soft water superior textile cleansing results can be had with improved feel and texture of the treated goods.

Among the sulphated fatty alcohols there is the same family relationship, including the same gradual change in properties as is found with ordinary soaps. For example, in the production of higher alcohols by the hydrogenation of coconut oil or the free fatty acids of coconut oil, all of the even numbered fatty saturated alcohol from C_6 to C_{18} are present. Changes in the properties of the ordinary soap with increasing number of carbon atoms are well known and by analogous changes in the composition of the sulphated fatty alcohols, varieties of combinations of properties may be produced. Thus by combining sulphated fatty alcohols of different carbon atom content, a variety of materials for special technical and soap purposes may be produced.

Procter & Gamble is offering "Drift," the packaged form of Gardinol to be sold by grocers for use like household soap chips. Other industrial marketing will refer to the specific types of Gardinol as Lorol, Ocenol, and under other special trade names.

Fig. 1—Michigan Alkali Co.'s new solid CO_2 plant, looking toward the shipping and storage department



Byproduct CO_2 Builds a New REFRIGERANT BUSINESS

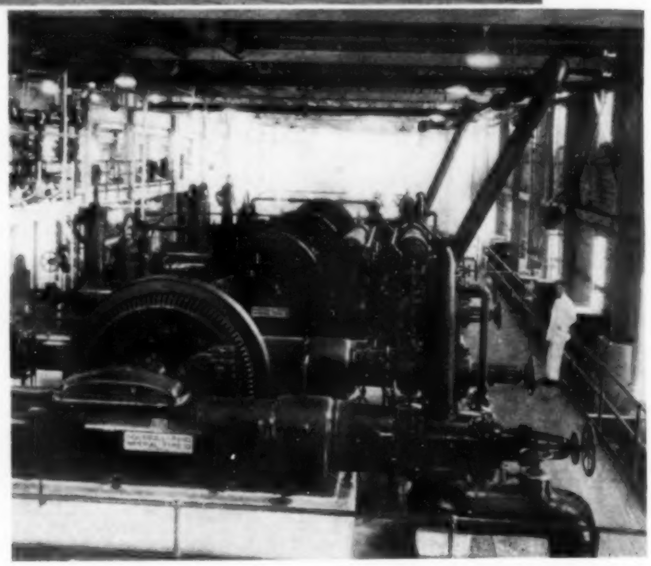


Fig. 2—Two primary and two secondary Ingersoll-Rand compressors of respectively four and two stages

By STEPHEN T. ORR

General Manager
Michigan Alkali Co.
Wyandotte, Mich.

THAT IT is possible to produce a solid refrigerant from liquid carbon dioxide, having properties superior to water ice for many purposes, has been known for nearly a century. Although the material was first produced in the solid form in 1834, it was not exploited commercially until 1925. The liquid CO_2 business was well advanced in that year, but it was not until 1928 that any appreciable quantity of the solid product was made. Since that year, production has increased at a rapid rate until in 1932, about 122,000,000 lb. was produced.

Having but twice the refrigerating effect of water ice, solid carbon dioxide might appear to have a somewhat limited field of application, in view of its considerably higher cost. However, certain of its properties, such as its compactness, its cleanliness, its dryness, its low temperature range (sublimation point —109.6 deg. F.), and its ease of preservation, make it desirable for many uses. For the shipment and preservation of certain food products, notably frozen fish fillets and ice cream, and for the icing of refrigerator cars, and trucks, it has been displacing water ice at an increasing rate. Carbon dioxide atmospheres have long been known to exercise a preservative action beneficial to certain food products.

In 1930, the Michigan Alkali Co. gave consideration to the use of waste carbon dioxide from its causticizing lime kilns for the production of solid CO_2. Early in the year the company built an experimental plant, employing the Carba process, and in December of the same year first broke ground for the present plant. The plant now in operation, which was designed and built through the combined efforts of our research and engineering departments, has a daily capacity of 150 tons and was put in operation on May 2, 1932. It is an interesting fact that the first ton made in the new plant was of salable quality and was shipped to the company's distributors. The new plant is located at Wyandotte, Mich., from which point shipments are made by motor truck, rail and water. The plant, at present, is the largest of its kind and provision has been made for its future expansion. Additional compressor capacity is now being installed with the expectation that plant capacity will shortly be increased by 50 per cent, to 225 tons of solid carbon dioxide per day.

The starting point of the process, of course, is the carbon dioxide gas which is obtained in the burning of lime for our causticizing plant. Because of the need for recovering this CO_2 the lime kilns are operated to avoid excess air in so far as is possible. From the kilns the gas passes to a water scrubber packed with lime rock for the removal of sulphur and dust. The gas thus purified, now containing only carbon dioxide, carbon monoxide, oxygen

and nitrogen, is then passed upward through absorption towers, countercurrent to a weak lye consisting of a solution of either sodium or potassium carbonate. A part of the carbon dioxide is absorbed by the solution, forming the bicarbonate which, at the temperature of operation of the absorbers, is a stable compound.

The bicarbonate lye, known as strong lye, leaves the absorbers and passes through a heat exchanger where it recovers heat from hot, weak lye which is leaving the lye boiler later to be described. The solution then enters the lye boiler where its temperature is raised to approximately 245 deg. F., with steam. At this temperature the bicarbonate breaks down, evolving CO_2 and forming the carbonate. The gas escapes through a rectifying section connected to the lye-boiler body, where it comes in contact with the entering strong lye from the heat exchanger, heating the strong or carbonated liquor and being itself reduced in temperature.

Gas then passes to a water cooler where its temperature is lowered still further and its water vapor content is greatly reduced. Condensate from the cooler returns to the weak lye circuit. The gas then passes to a gasometer where it is held prior to compression in the solid CO_2 plant.

The plant is of modern, reinforced-concrete construction, so designed that considerable additional capacity can be added without change in the original layout. The exterior view, Fig. 1, looks toward the shipping end in which are the wrapping, weighing and storing facilities. Truck shipments are made from the doorways shown in the view. Railroad shipments are made from a track situated at the right of the building. Within the rearward section of the building are the compressors, liquid CO_2 receivers and presses. The compressor section, shown in Fig. 2, appears at the right as one enters from the shipping department, while the 18 presses are lined up at the left.

The Carba process employed is of Swiss development and is extensively used on the Continent. It is installed in the United States by the International Carbonic Engineering Co., of Kennett Square, Pa. In its original form, the process employed a novel method for producing solid carbon-dioxide blocks without the use of presses. Briefly, this method consisted in the expansion of carbon dioxide liquid to form a wet, snowy mass which was then frozen by releasing the pressure so as to solidify the liquid portion. (*Chem. & Met.*, p. 272, May, 1931.) As the capacity by this method was less than could be obtained with presses, special presses were designed by the International company and built under the company's acquired patents by the Baldwin-Southwark Co., Philadelphia, Pa., and the Hydraulic Press Mfg. Co., of Mount Gilead, Ohio.

The installation, as it is at present operated, employs two sets of compressors, each set consisting of two duplex-frame, four-cornered machines built by the Ingersoll-Rand Co. The two primary compressors are four-stage machines which compress gas from the gasometer to the operating pressure of about 1,100 lb. Return or blow-back gases from the presses and expansion bottles are recompressed in the two stages of the secondary compressors to the 1,100-lb. working pressure. An additional compressor unit built by the Worthington Co., comprising one primary and one secondary compressor, is now being added to increase our plant capacity to the 225 tons per day noted above.

This compressor installation is notable from several standpoints. It is the largest grouping of equipment of this type in any one plant and it is of superior flexibility. The latter has been accomplished through the use of adjustable clearance pockets on all cylinders. Compressor performance is based on a condenser water temperature of 78 deg. F. or lower.

To illustrate the compression and freezing cycle, the flow diagram of Fig. 4 is given. Gas from the fourth stage of the primary compressor is passed through a water cooler and condensed, passing as liquid CO_2 to a series of liquid storage vessels. As required for the presses, liquid is withdrawn to an expansion tank where the pressure is partially released in order to accomplish preliminary cooling of the liquid. Released gas passes

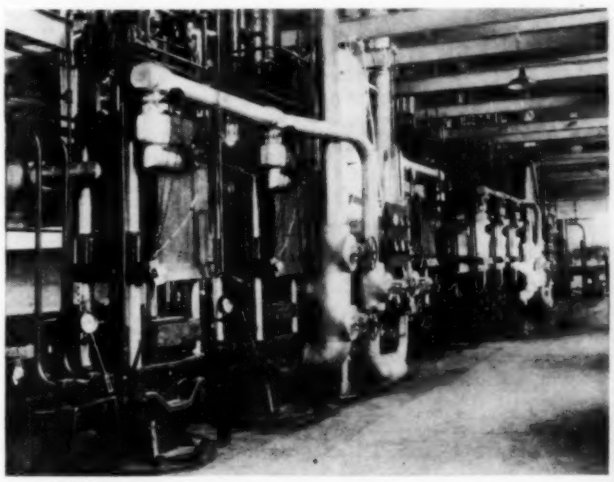


Fig. 3—Carba solid CO_2 presses built by Baldwin-Southwark Co.

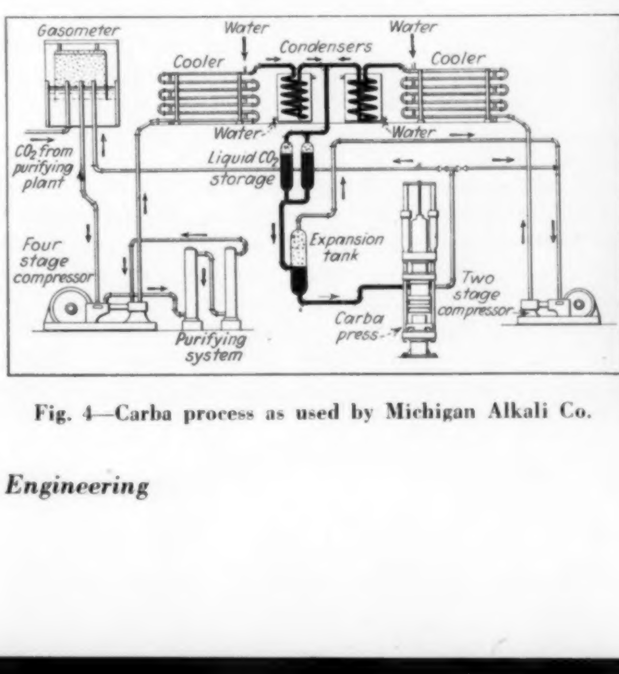
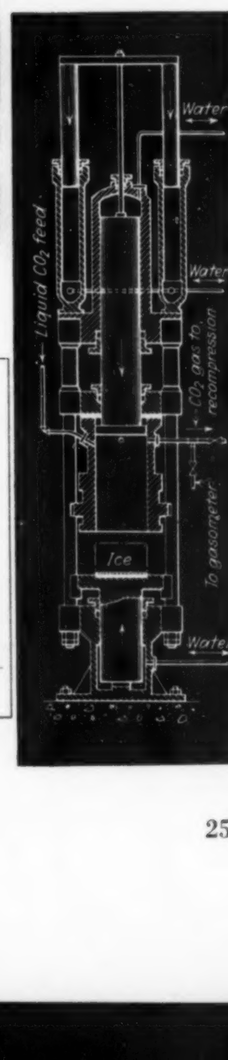


Fig. 4—Carba process as used by Michigan Alkali Co.

Fig. 5—Cross-section of Carba solid CO_2 press



to the two-stage secondary compressor where it is recompressed to the 1,100 lb. working pressure for recooling and condensing. Liquid CO_2 from the expansion tank is then expanded through a nozzle into the upper part of the Carba press shown in cross-section in Fig. 5.

This press is of interesting construction, serving as it does for the several purposes of expanding the liquid to produce snow, compacting the snow to a 20x20x10-in. block and discharging the block to the ice conveyor behind the line of presses. The press consists of three major elements: an insulated, immovable chamber in which the pressure is released; an hydraulic piston which serves as the bottom of the expansion chamber and is lowered to remove the finished block of ice from the expansion chamber; and an upper hydraulic piston which is lowered to compact the snow.

The cycle of operations is as follows: With the upper ram at the top, and the lower ram closing the bottom of the expansion chamber, liquid CO_2 is admitted for a predetermined time until sufficient snow has formed. During this period, gas formed from the expansion is conducted from the expansion chamber to the secondary compressor. The liquid feed is then cut off and the residual pressure in the expansion chamber released to the gasometer. When this is accomplished, the upper ram is lowered to compact the snow into a dense cake, having a specific gravity of about 1.5. The upper ram is now raised, then the lower ram, upon which rests the finished block, is lowered. The presses, it is interesting to note, are equipped with indicators for showing the height of the compressed block; and with guards which protect the operator from escaping gases. There are 18 presses, each of 250 tons hydraulic capacity, of which 12 are at present used for the 150 ton daily output.

Two auxiliary hydraulic cylinders at the top of the press serve to return the upper plunger to its highest position. The ice cake is now pushed from the lower ram to a mechanically operated roller conveyor made by the Lamson Co., on which it travels the length of the presses to a band saw situated near the storage room. Here it is sawed lengthwise, after which the cake continues to a turntable, where it is turned through 90 deg., and then passed once more through a band saw, thus forming four cakes, each 10x10x10 in. The cakes are then made to travel in single file to a wrapping station within the storage room. Here each 10-in. cube is wrapped, sealed and loaded on a skid holding approximately 2½ tons. The skid is picked up by an overhead crane, weighed and lowered into a storage pit. There are five of these pits, each holding 60 tons or a total capacity of 300 tons. The pits are heavily insulated with cork and are provided with hatch covers on top. As the losses from the bunkers are almost negligible, reserve can be accumulated for emergency or peak demands.

Fighting Depression With Increased Expenditures

By GUSTAVE T. REICH
Pennsylvania Sugar Co.
Philadelphia, Pa.

When the depression struck, every firm was at a cross-roads; how long it would last, nor what should be the logical attitude under such conditions, no one knew. Companies with cash reserves generally tried to increase them. But today, with inflation impending, even if they succeeded they are probably in no better position financially than they were when the depression began.

About three years ago we laid out a program that drew heavily on our cash reserves; but in so doing we are convinced that, in depleting our cash assets, we have bettered our competitive position. Our program included improvements in plant and in products; greater employee efficiency; development of new products; better use of byproducts; and finally, increase in our research department and its facilities.

From the viewpoint of our engineering department, the depression transferred a large part of the reserve from the treasury into plant improvements. With "prosperity just around the corner" we prepared to meet it while construction costs were low. Plant capacity was not increased, but the improvements made possible dividends which otherwise would have had to come from surplus. Customers were educated to demand improved quality and remarkable advances were accomplished.

Steam and power plants were rebuilt, using 400-lb. pressure and superheat. Process changes reduced steam demand and heat exchangers were added to extract heat from waste water. Heating surfaces were increased to permit lower back pressure on the turbine and increase the extraction of power. Power was better applied and anti-friction bearings installed. Unit power requirements were decreased, but the demand for power was nearly doubled through the installation of mechanized equipment and the further processing of byproducts.

We rearranged equipment and modernized lighting and ventilation, thus improving working conditions and salvaging an acre of floor space, out of a total of 20, making possible new installations. Steam, water and power meters were provided for all stations. All manner of automatic controls were employed, including controllers for pH, vacuum pan boiling, and furnace regulation.

New purchasing arrangements were made, new competition invited and stocks decreased. Employment is now supervised by a medical officer. The chemical department was increased and new research facilities were built at the Philadelphia and Carlstadt plants. A bacteriological department was added for supervision of sugar used in canneries. New products were developed and marketed for the lacquer industry.

All CO_2 from our distillery is marketed either as liquid or as the solid product. For this purpose a new solid CO_2 plant of 50 tons daily capacity was erected.

Much attention has been given to the elimination of corrosion. New packages for our products have been developed. We have reconstructed and rearranged our stills, doubled their capacity and halved their operating force. In all of this development of the past three years we have spent over $2,000,000, invested in depression to prepare for better days ahead.

PROGRESS IN UNIT OPERATIONS

IN the following pages it will be our aim to survey briefly the principal advances in the unit operations of chemical engineering, and in process equipment, during a period corresponding roughly to that of the depression. No such survey can be complete, nor is it possible to limit discussion rigorously to the last four years. Nevertheless, in taking the broad view of the entire field, it is our hope to bring up to date the similar reviews published in earlier years.

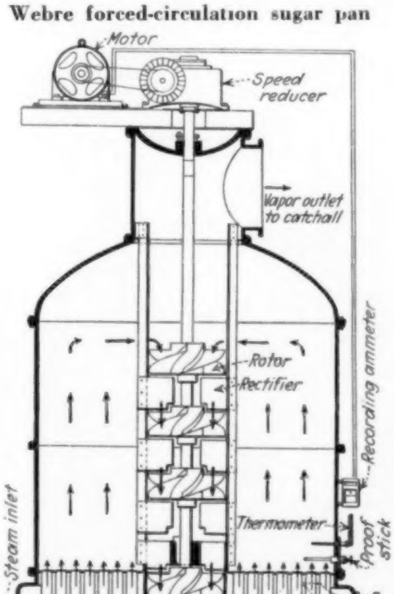
Design Improvements Bring About Better Evaporation

PROGRESS in evaporator design during the depression period has been largely directed toward the improvement of existing equipment. It has been noted by Webre (*Chem. & Met.*, p. 267, Apr., 1931) that improvements have been chiefly in the following: reduction in entrainment losses; increasing use of forced circulation where conditions warrant; and better arrangement of the heating surfaces to give better heat transfer. There is increasing use of the expedient of recovering some of the vapor from one or more evaporator effects for use as a heating medium elsewhere in the plant.

It has been recognized that the prevention of entrainment in evaporators can be accomplished only by impinging the vapors upon wetted surfaces or by forcing them through sheets of liquid. The reason for this lies in the fact that the comparatively large bubbles produced at high vacuum are of extremely low density, and cannot be removed by ordinary centrifugal means. One method of accomplishing the impingement of these bubbles is to place two semi-circular baffles on opposite sides of the vapor space, one above the other. As soon as the bubbles impinge they form drops which are returned to the evaporating liquor. This method is insufficient for complete removal, necessitating an additional separator. Another method very successfully employed in forced circulation evaporators is to place a mushroom-shaped baffle above the exit of the heating tubes. Vapor released as the liquor discharges from the tubes is forced to pass through the sheet of liquor continuously spurting downward from the circumference of the mushroom.

Evaporator design at present has turned very largely toward the use of vertical, cylindrical bodies. Except in infrequent cases where tube replacements must frequently be made, or where no salting is encountered, horizontal-tube evaporators are seldom used. Vertical tube bundles, either with a central or an angular downtake, are now almost standard. This statement, of course, applies to evaporators other than the rapid-circulation, climbing-film and forced-circulation types.

Webre forced-circulation sugar pan



The last named has been very extensively applied, almost to the exclusion of other methods, in the preliminary evaporation of caustic-soda liquors. It has also been largely used for pulp and paper liquors, for glycerine and soap lyes, for common salt and for fermentation slops.

The increasing use of special materials of construction is to be noted. Buffalo Foundry & Machine Co. has employed a number of new methods in the production of its lead evaporators. Tube sheets are covered with sheet lead, making the protective covering an integral part of the tube sheet. The tubes are also of a new type, consisting of pure lead reinforced by a perforated inner tube which adds strength without impairing the heat transfer.

Several new evaporators of a more or less radically different design have appeared in recent years. A new vacuum pan, designed by A. L. Webre for the U. S. Pipe & Foundry Co., has greatly simplified the crystallization of sugar. About five years ago, Mr. Webre began a series of extensive tests to determine what actually goes on within the sugar pan. He found that the difficulties with existing methods included the following: Incoming feed was being improperly mixed with the masse cuite; local overheating due to sluggish motion in the tubes was being encountered, particularly toward the end of the strike; and serious diminution in the evaporation rate was taking place after the material level passed a certain point too low for practical operation.

The new pan, illustrated in the accompanying drawing, is similar in many ways to the old one, except that means for forced circulation have been added. The circulator consists of a number of screw pump elements mounted on a vertical shaft and driven from the top by a suitable speed-reduction gear. The screw elements are of substantially the same diameter as the downtake pipe. Between the successive screw elements are rectifying vanes to arrest the swirl of the liquor, so that its downward displacement is not impaired.

Fresh syrup is admitted continuously into the strike, at a point directly beneath the bottom rotor, accomplishing thorough mixing of the feed with the recirculated masse cuite.

Since this pan was developed, it has been found possible to cool the masse cuite in the pan itself, without any danger of forming false strike, or "smear." To do so, water is admitted on the steam side of the heating surface, at a temperature equal to or higher than that of the strike. The vacuum in the pan is broken and a vacuum is created in the steam space, thus causing the hot water to flash into steam and producing a cooling effect which gradually cools the masse cuite in circulation. As the temperature of the strike becomes lower, the vacuum in the steam space becomes higher, thus maintaining a substantial temperature difference. By this method it has been possible to perform in the vacuum pan, in four hours, the same work done in the crystallizers in three days.

A very simple means of controlling this pan has been developed. The power consumed by the circulator is a measure of the viscosity of the strike. Consequently, it is only necessary to measure the amperage in one phase of the motor supply to obtain an excellent measure of the viscosity of the pan contents. This system makes operation simple, eliminates all guess work and permits one operator to attend to several units simultaneously.

Other new equipment has been brought out by Struthers-Wells Co. and the Buffalo Foundry & Machine Co. The Struthers-Wells evaporator, known as the I.H.V., departs from the usual practice in rapid-circulation evaporators by omitting the usual large vapor space, relying instead upon a new design of entrainment separator to produce a dry vapor. This equipment consists of an inclined tube bundle terminating at the top in a small vapor head from which a return pipe drops to the bottom and a vapor line extends downward to a centrifugal separator of high efficiency. The recent Buffalo Foundry design employs a vertical tube bundle, with or without an external pump, placed outside the evaporator body and to one side, for easy cleaning.

Research Yielding Important Advances In Distillation Practice

By DONALD F. OTHMER
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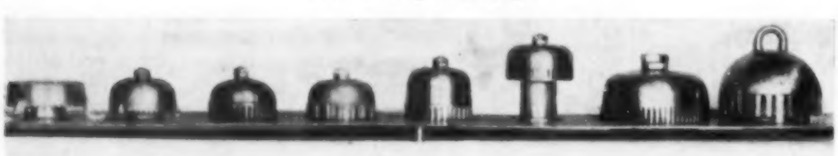
Polytechnic Institute of Brooklyn
Brooklyn, N. Y.

DISTILLATION, which usually means rectification and/or the evaporation of other liquids than water alone, has progressed in the last few years more by development and integration along well established lines rather than through the startling conquest of new fields. More and more as chemical industry progresses, distillation—in the well established terminology a "unit operation"—must be looked upon as a "unit process," for its particular fields of chemical engineering. This change in view is necessary because of the chemical reactions which take place during the distillation; and more especially because of the involved technique which the range of the distiller's art—and science—leads to from the principles of vapor-liquid equilibrium.

Refined, and usually continuous, processes have been developed to take the place of earlier and more haphazard "banging over"—to use a stillman's phrase for inefficient operation. With this has gone the necessity, in these competitive times, for more careful design of units. The coppersmith who formerly placed three times as many downcomers per plate as necessary because he "figured it a good idea to get the wash off them plates as quick as could be" is not building any of the copper units for modern processes where the liquid passing these circular weirs, if added together for all the plates in a single column, would amount to as much as 5 million gal. per day.

Bell caps, old and new: fourth and fifth from left are new Vulcan tangential caps

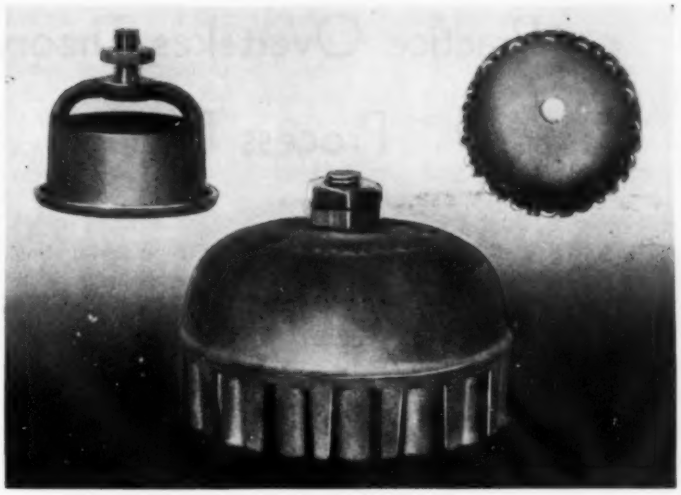


Segment of 21-ft. bubble tray (M. W. Kellogg & Co.)

A rectifying column, in one sense a heat engine of very low thermal efficiency, is simply a device for the contacting of liquid with vapor. The thermal efficiency is tremendously increased by successive and countercurrent contacting. Packed columns, except in small sizes and for gas washing and other special applications, are of little interest. Perforated plates, because of their narrow range of operation, inefficiency, and loss of tray holdup on even instantaneous interruption, are also passing except in some special cases where large quantities of solids in the feed might clog the bell-type cap. The only notable example in general use is the perforated plate beer column.

The film-type column of either the mechanical spray or the falling-curtain type has never been used extensively; and indeed the mechanical type would

have to exhibit a positive advantage in a definite use to pay for the additional cost of the rotating machinery involved, and especially the operating cost. The use of external power to mix a liquid intimately in a vapor stream is basically uneconomical when the expanding energy of vapors released from the slight pressure of a still pot is available at no appreciable, extra expense over that for evaporation, and may be readily used by various types of orifices and jets in bringing into contact the vapor in the liquid.



Tangential bubbling cap, showing in the small inserts the thimble used to attach the cap to the tray, together with a bottom view of the cap (Vulcan Copper and Supply Co.).

Bubbling cap columns, usually with bell caps, have been for many years the favored type; and, unless some radically new device is introduced, they will doubtless continue to be preferred. Of the numerous modifications and improvements suggested in recent years, the only one to have sufficient merit to secure a widespread use in various industries has been the Vulcan tangentional bubbling cap. Over a third of a million of these caps have been installed in a diversity of separating operations. Above is one of these of the opposed tangentional type, in which alternate streams of vapor issuing from the slots are directed to meet in the liquid a short distance from the cap; and the resulting violent agitation insures intimate contact. In carefully controlled tests using an industrial column fitted with these caps, an efficiency in separating several pairs of liquids of as much as a third greater than the older cap with radial slots was shown.

The well tested method of column construction has thus been improved in efficiency; and, similarly, the important appendages, still pot and condensers, have also yielded to improved design. These are pieces of heat-transfer equipment; pure, but not always so simple. The forced circulation of liquid through heating tubes was first applied in this country by the Whiting Corp. to the concentration of aqueous solutions; and then, in the oil industry, to the high-vacuum distillation of lubricating oils. Since then at least one installation in a very specialized distillation process was designed to use not only a forced circulation heating system of improved design at the base of a tall column, but salt hoppers for salt removal as well. Other designs, first pioneered in evaporator practice, are making the base heater anything but the old pot with coils.

Likewise that old symbol of the distiller, a worm condenser in a tank of water, is going. Water velocity past the heat-transfer surface approached zero as a common limit; while, on the contrary, one progressive builder of distillation equipment, in keeping with the modern knowledge of heat transfer, regularly designs and builds all condensers and heat interchangers with a water and liquor velocity of around 5 ft. per second.

More noticeable than these improvements in equipment design, in which the modern distillation engineer takes advantage of all of the advances of related fields of chemical engineering, are the improved facilities for operation and control of distillation. Steam meters of all types, temperature controllers and remote recorders, pressure gages and controllers sensitive to a pressure of a quarter ounce per square inch, and level controls are generously scattered around the modern plant.

Even more important in controlling distillation processes are liquid flow meters for showing liquid flow in every part of the system. The material balance of a battery of interconnected columns must be maintained sensibly constant or the complicated separation operation will break down somewhere. It is necessary to have an exact indication of the rate of flow in each of these streams as well as its composition (the latter usually determined from boiling temperatures or by specific gravity indicators). Even the older columns as, for example, many in the alcohol industry, are being equipped with meters to indicate the reflux ratio returned to each column.

The progress in any individual industry is, as stated above, largely concerned with distillation *processes*. One of the most effective tools is the so-called azeotropic distillation, often involving, among other accessories, continuous decanters; another is the coupling of countercurrent liquid extraction with distillation units; still others involve all manner of solvent-recovery apparatus; and vapor and liquid processing equipment under every possible temperature and pressure condition.

Although there has been no important new installation in the United States during the last few years for the production of absolute alcohol by rectification and azeotropic distillation, current activity toward that end is feverish in some quarters because of the proposed "Motor-Fuel-from-Grain" legislation. Motor-fuel-from-alcohol-from-grain-from-the-ground *vs.* motor fuel directly from the ground is about a dozen times as expensive; but the agrarian enthusiasts are serving at least one good end in their scrambled economics by making more people conscious of newer methods of distillation.

More real progress is to be noted in the acetic acid industry, where vapor and liquid extraction cycles, coupled with improved distillation technique, lowers by an important fraction the cost of producing glacial acetic acid, directly rather than chemically from pyroligneous and other sources of dilute acid. An equally impressive step has been taken in the continuous distillation of the higher fatty acids in units of tremendous size and complexity, considering the high vacuum of a couple of millimeters, prevailing. The usual decomposition due to local superheating and other factors is almost entirely eliminated in units which compete for honors with the more recent acetic units, for massive construction and carefully engineered details in modern distillation equipment.

Intensive research is being pressed on distillation problems by one or two companies specializing in distillation equipment for the chemical, rather than the oil, industries; and from this as well as the considerable amount of investigation under way at almost every recognized school of chemical engineering, many advances in equipment and processes may be expected.

Practice Overtakes Theory in Process Drying

DRYING TECHNIQUE, within the period just passed, has shown notable improvement in a number of directions. On the one hand, there is to be observed a more faithful application of the principles of drying in equipment supplied for the purpose; while on the other, the theory, particularly in the hands of Sherwood, of M.I.T., and Newman, of Cooper Union, has advanced to a marked degree. The work of these men has been directed largely toward the mechanism of air drying. Sherwood has investigated drying rates as influenced by the air velocity and the diffusion of moisture from the interior of solids, while the same subject has been considered by Newman who has also introduced the concept of a surface resistance in drying, similar to that met in heat transfer. Still another concept, that of forced diffusion, has been developed by Weisselberg.

An important new tool for the drying engineer is to be found in the Weisselberg water-air-mixture chart (*Chem. & Met.*, p. 426, Aug. 1932), which is based upon the Mollier water-air-mixture chart previously in use in Europe. Since the publication of the chart (*loc. cit.*) above, Mr. Weisselberg has considerably extended its usefulness. In its revised form, it was presented in October, 1932, before the process industries committee of the A.S.M.E.

Diffusion Controls Drying

Returning to the application of recent theory, it has been shown by Sherwood (*Ind. Eng. Chem.*, **22**, 1929, p. 133) that the diffusion of liquids through solids from points of higher concentration to those of lower concentration follows the fundamental laws of heat diffusion. Once the rate of evaporation from the surface becomes limited by insufficient moisture diffusion to the surface, internal liquid diffusion controls the rate of drying and the heat supply should be regulated accordingly.

Further than this, if it could be done, Weisselberg has noted (*loc. cit.*) that the rate of natural diffusion would be increased by the application of heat directly to the moisture inside the material. This cannot ordinarily be accomplished, but the same end is reached if the reduction of the relative humidity of the surrounding air is accompanied by a lowering of its temperature. When the outside temperature is higher than that of the material, diffusion will cease until the moisture inside acquires the temperature of the air, but with the reverse condition, diffusion is forced to proceed at a higher rate and drying may thus be speeded up.

In the application of the improved theory to drying equipment, a number of trends are to be noted. Particularly, recognition is being given to the need for recycling and reheating of the drying air in order to obtain high efficiency. It is recognized that for greatest economy, the air should leave the dryer as nearly saturated as possible and at the highest permissible temperature. Forced diffusion is being applied in some of the new equipment to increase the rate of drying, coincident with high efficiency.

Perhaps these principles are most fully exemplified in the Büttner dryer, introduced into the United States from Germany about two years ago. This dryer appears in several modifications, but in every case certain fundamental principles are adhered to. In dryers for web material, such as paper and textiles, the material is carried around a drum of suitable construction, within which are numerous heating coils or elements over which air is blown by a turbo fan. The effect of this fan is continually to recirculate the air in a direction counter to the material flow, reheating it a large number of times and contacting it with the web between reheatings.

In dryers intended for granular materials, rotating hearths composed of segments separated by gaps are placed one above another and rotated on a vertical shaft. Within the hearths and concentric with them are turbine fans which circulate air over the material carried on the segments, and recirculate it past heating coils placed outside the hearth section. Again the effect is to recirculate the same air frequently, heating it between recirculations so as to discharge it as nearly saturated as possible. Material enters the top hearth, travels through 360 deg. and is scraped to a lower hearth after which this action is repeated until it has been displaced from the lowest pass to a discharge conveyor.

Several interesting mechanisms for use in drying equipment have been developed by Proctor & Schwartz, Inc., in recent years. One of these is the roll-loop dryer for web materials in which the web is carried in festoons, but, in addition, is moved over rolls in its passage to the dry end. The effect of this movement of the rolls is to eliminate any possibility of stick marking which might arise in ordinary festoon drying; at the same time, the loops of material are free to expand and contract, as they cannot do in the ordinary roller dryer.

Drying in Reversing Pans

Another ingenious dryer mechanism developed by this concern offers very large storage capacity within a comparatively small dryer housing. It is intended for granular materials which would ordinarily be dried in trays. It is known as the reversing pan dryer and consists of one or more endless conveyors arranged horizontally. The pans are attached to the conveyor chains at the angle of rest of the material so that air can be blown between the pans and over the surface of the material. When the end of the conveyor run is reached, the pans reverse and dump their contents to the lower run of the conveyor, so that a double capacity is obtained. At the end of the second run material may be dumped to a second conveyor and when this has been utilized, to a third conveyor if necessary.

For handling materials that tend to ball or stick in an ordinary rotary, Louisville Drying Machinery Co. brought out its new type L machine, a rotary tubular dryer in which are a number of longitudinal, box-like flues attached to the inner periphery instead of the customary central tube. Furnace gases are conducted through these flues and then return through the dryer from the discharge end to the stack. Flights attached to the flues serve to lift the material and cascade it through the returning gases. The machine is said to have eliminated the structural difficulties of the central-tube direct dryer and to have shown thermal efficiency as high as 85 per cent.

Still another air dryer of novel type is the Dwight-Lloyd Oliver which is, in effect, an extension of the principle of the Oliver top-feed filter. In the "D.L.O." dryer, the filter drum is replaced by a traveling bed consisting of screen-covered pallets which circulate in a roughly elliptical path in equipment similar to the Dwight-Lloyd sintering machine. Heated air is then forced by a blower downwardly through the bed of wet material with the result that

some of the moisture is actually blown out, while the remainder is evaporated. As a consequence of this blowing action, the machine is said to show remarkable thermal efficiency in the drying of non-packing, granular and crystalline materials.

A new spray dryer which departs markedly from customary practice is the Peebles dryer of the Western Precipitation Co., which was described at length by Manning (*Chem. & Met.*, p. 702, Dec., 1931). As is done in other spray dryers, material is sprayed horizontally in all directions by means of a high-speed turbine-type disperser. However, due to the peculiar construction of the hot-air circulating system, material flashes rapidly through a high temperature zone rotating in one direction, and immediately enters a low temperature zone rotating in the opposite direction. In the latter the remainder of moisture is removed slowly and without danger of heat injury.

Air Conditioning

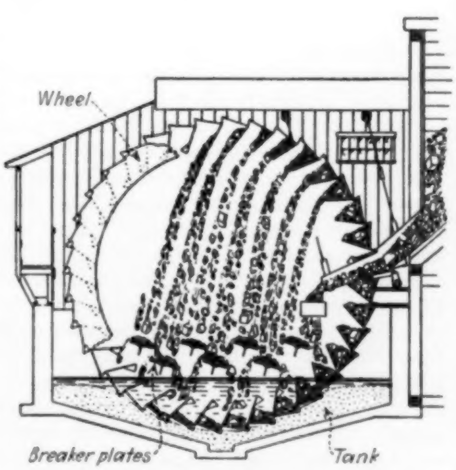
Recent trends in industrial air conditioning point in many cases toward a preference for the small unit type of equipment rather than the central station type which was formerly most in favor. This tendency arises from a number of causes, not the least of which is the saving in large duct work which follows the use of the unit air conditioner. Further than this is the convenience of being able to control different departments according to their various needs. Several concerns have been very active in the development of unit equipment in recent months.

For installations requiring dehumidification, the vacuum cooler is now competing actively with the mechanical refrigerating machine. At least seven companies are now engaged in building vacuum coolers, and two of them are using this equipment in air conditioners of their own manufacture. Whereas it was first believed that the vacuum cooler was efficient in comparison with mechanical refrigeration only in the smaller sizes, one maker has recently used this method in a machine of 75 tons refrigeration capacity with apparently greater economy than is possible with ammonia.

One maker has recently developed a small mechanical unit for room cooling which, it is understood, is also to be applied in larger sizes to unit industrial work. This employs a two-cylinder opposed construction for the compressor, with all working parts hermetically sealed as in the case of certain of the household refrigerators.

Grinding Progresses Toward Higher Efficiency

INVESTIGATORS in the field of grinding, in recent years, have been much interested in attempting to correlate theory and practice. Actual results are still far from the theoretical, but there is reason to believe that they are now being brought closer together. Particularly, attempts are being made to correlate the results of small-scale grinding tests with actual practice. Another study of considerable interest is the research of Fahrenwald, at the University of Idaho, on the effect of increased speed in ball-mill grinding. Results indicate that there is some advantage in operating at speeds higher than those heretofore employed. Another study of scientific interest was conducted by metallurgists of the U. S. Bureau of Mines who shattered minerals without grinding, employing the explosive power of steam pressure suddenly released. Preliminary reports on the latter study were given at the New York meeting of the A. I. M. E. in 1932 and 1933.



Side elevation of Hadsel mill

It is to be noted in connection with the wide divergence between theory and practice in power required for mills, that further extension of the principle of the closed circuit, to circulating loads as high as 10 to 1, has shown that the theoretical advantage of this practice is retained. The power consumption for this high recycling rate is large, but the power saving in grinding is still greater and it is not yet known at what point the economic limit of recycling would be reached.

Several new pieces of equipment, some of decidedly new type, appeared within the last three or four years. Fuller-Lehigh Co. modified its ball-and-race type of pulverizer so that two sets of balls are driven between stationary upper and lower races by a rotating race placed between the rows of balls. Pressure is controlled by spring loading of the upper race. The mill is air-swept and operates in closed circuit with an air separator.

Patterson Foundry & Machine Co. developed a crusher of very novel type. This is the "Gyrocentric" and consists of a rotating horizontal shaft carrying an eccentric which in turn carries on its surface roller bearings supporting a cylinder. This unit is contained within a crusher body, bounded on the surfaces parallel to the rotor, by semi-cylindrical crushing plates. Material fed into the crusher body is broken between the cylinder and the side plates as the eccentric rotates.

Totally different from any other grinding machinery in existence is the Hadsel mill which is being developed by the Hardinge Co. Outstanding features of the mill are its low power consumption and the fact that it will take lumps as large as 2 ft. in diameter and reduce them in one operation to any fineness required, such, for example, as 95 per cent through 200 mesh. The mill consists of a large revolving bucket wheel which dips into a shallow tank. Coarse material is fed into the wheel, by which it is elevated and then dropped upon a series of smooth, stationary, striking plates set at a slight angle. Material then falls back into the lower buckets, again to be lifted and dropped. Removal of the finished product is accomplished by a flow of water through the tank, the rate of which can be varied at will to adjust the size of finished product removed.

A centrifugal ball mill, brought into this country from abroad by the Supex Equipment Co., is another radically different development. Balls and material are thrown from a rotating, dish-like element against a stationary, cylindrical grinding section. From here they are thrown back again into the rotating element and the operation is repeated. Air sweeping through the mill removes the

finer particles and carries them to a centrifugal sifting device, from which all oversize is rejected and returned to the mill.

Very recently, Smith Engineering Co. introduced a new type of cone crusher which differs considerably from previous equipment of this type. This is known as the "Gyrasphere," a name which follows from its use of a spherical head instead of the usual conical mantle. The advantage of this design is said to be the production of a more cubical product.

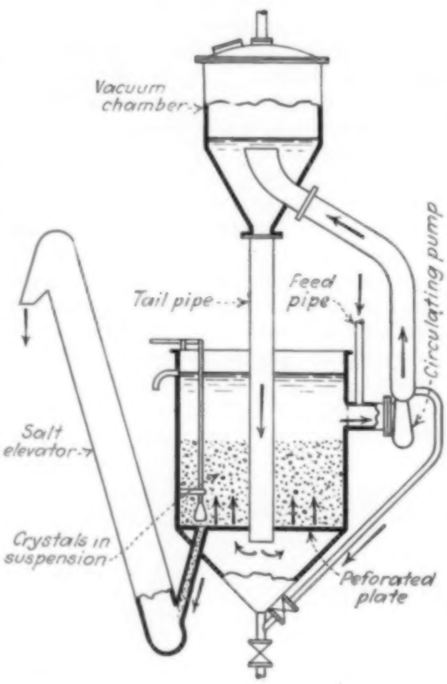
Vacuum Crystallization Makes Important Strides

RECENT improvements in crystallization are intimately connected with the rediscovery of the old vacuum cooling process. In one stage or another of its development, this method has been used for years, first by the potash industry of Europe and more recently in the Searles Lake potash operations and in the production of potash from sylvinite near Carlsbad, N. M.

In the United States, vacuum crystallizers have been developed and installed by two groups of interests. Swenson Evaporator Co. made the first installations, and later a somewhat different form of vacuum crystallizer, the so-called Oslo type, developed in Norway, was installed in the plant of the Pyrites Co., Ltd., at Wilmington, Del.

An important factor favoring the vacuum crystallizer is that the cooling temperature is not necessarily limited to that of the available cooling medium. The reason for this is that the vapors leaving the evaporator body may be compressed with a steam-jet compressor to a point where the cooling medium suffices to bring about condensation. In the Swenson type (*Chem. & Met.*, p. 133, March, 1932), the evaporator body consists of a vertical, cylindrical shell of sufficient size to provide ample vapor space above the solution level. Hot solution is fed in continuously and the cooled solution is continuously removed with the crystals in suspension. Cooling and concentrating are effected by maintaining the desired vacuum in the vapor space and thus permitting the feed solution to flash off vapor until its temperature has fallen to a point approaching that corresponding to the vacuum maintained.

If considerable cooling is to be accomplished, it is generally desirable to employ two or more stages. For example, feed liquor at 210 deg. F. might be cooled to 160 deg. in the first body, to 105 deg. in the second body,



Diagrammatic section of Oslo crystallizer

and to 80 deg. in the third body. If cooling water were available at 75 deg., it would be necessary to employ thermocompression of the last stage vapor to maintain the desired differential.

One very important advantage that arises from the use of the vacuum crystallizer is that it has no difficult heat transfer problem. There is no wall through which heat must pass from the cooling medium to the liquor to be cooled. Obviously, the materials of construction problem is greatly simplified. Rubber-lined bodies, for example, are readily employed.

One interesting example of the Swenson vacuum cooler is to be found in the new plant of U. S. Potash Co., near Carlsbad, N. M. In this installation, the temperature of the saturated solution is reduced from its boiling point of 227 deg. F. to the crystallizing temperature of 90 deg. in three steps. The solution is saturated with respect to both KCl and NaCl. It is desired, of course, to salt out only the KCl. This can be accomplished to a sufficient degree if the solution is cooled without evaporation. Loss of water, however, would also precipitate NaCl. Consequently, softened water in quantity equal to that removed by evaporation from each crystallizer body is continuously added so as to keep the concentration constant and maintain the salt in solution.

Some of the most valuable of the newer discoveries in regard to crystallization control are embodied in the Oslo crystallizer (*Chem. & Met.*, p. 594, Nov., 1932). The development of this apparatus followed recognition of that stage of supersaturation known as "metastable." Within the field of supersaturation are two regions, the metastable and the labile. In the former, crystallization will take place only on a pre-existing crystal or other nucleus. In the latter, crystallization occurs without any outside influence. Furthermore, the formation of seed crystals requires time, so that salt will not be precipitated immediately even when supersaturation is increased above the metastable limit.

An understanding of these and other factors made it possible to set up certain criteria for the design of suitable equipment for controlled crystallization: (1) A solution must not be supersaturated beyond its metastable limit if crystallization on the walls of the apparatus is to be avoided. (2) A large total crystal surface is necessary to obtain a high rate of production if excessive supersaturation is to be avoided. (3) The crystals must be kept in constant motion but this must not be so violent as to form a large number of new crystals by attrition. (4) New crystals formed should equal the number of full-grown crystals removed from the equipment.

In the Oslo system, solution is first cooled and evaporated in a vacuum body to a point within the metastable field. After concentration it sinks through a tail pipe into the conical bottom of a crystallizing vessel, from which it flows upward through a perforated plate. As it rises its flow maintains a large number of crystals in suspension. Then, having lost its supersaturation in producing crystal growth, the solution leaves the crystallizer and passes through a circulating pump, where it is mixed with fresh feed and returned to the evaporator body. Crystals are removed continuously from the crystallizing vessel by means of a salt elevator.

TECHNOLOGY ADVANCES

Adsorption and Absorption Developments

DURING the last three years much attention has been given to the method of purifying water by the use of activated carbon. Originally the carbon was used in granular form only, in beds, through which the water was passed. In 1930, at the St. Louis meeting of American Water Works Association, G. R. Spalding called attention to the advantage of using carbon in powdered form for municipal water purification, particularly in cases of intermittent and relatively short periods of objectionable tastes and odors. Since that time powdered product has been used almost exclusively for this purpose.

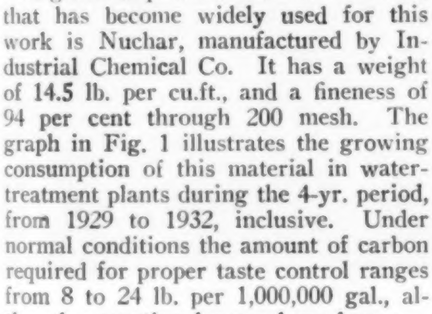
Sterilization of water by the use of liquid chlorine, although it offers perfect safety, has the disadvantage of bringing out unpleasant odors and an unpalatable taste of oily secretions of algae found in most waters, a result of chemical reactions between the chlorine and these oils. Treatment of the water with activated carbon, subsequent to the chlorination, quickly and safely eliminates these objectionable features.

A grade of powdered activated carbon that has become widely used for this work is Nuchar, manufactured by Industrial Chemical Co. It has a weight of 14.5 lb. per cu.ft., and a fineness of 94 per cent through 200 mesh. The graph in Fig. 1 illustrates the growing consumption of this material in water-treatment plants during the 4-yr. period, from 1929 to 1932, inclusive. Under normal conditions the amount of carbon required for proper taste control ranges from 8 to 24 lb. per 1,000,000 gal., although exceptional cases have been encountered where dual application has been necessary.

In industrial plants, in the manufacture of food products and in bottling works, where water of highest purity and with no objectionable taste is most essential, the granular form of activated carbon is most commonly used.

Another type is the Hydrodarco, developed for International Filter Co. by the Darco Corp. A battery of Hydrodarco purifiers is shown in Fig. 2.

Fig. 1. Number of plants using Aqua Nuchar activated carbon



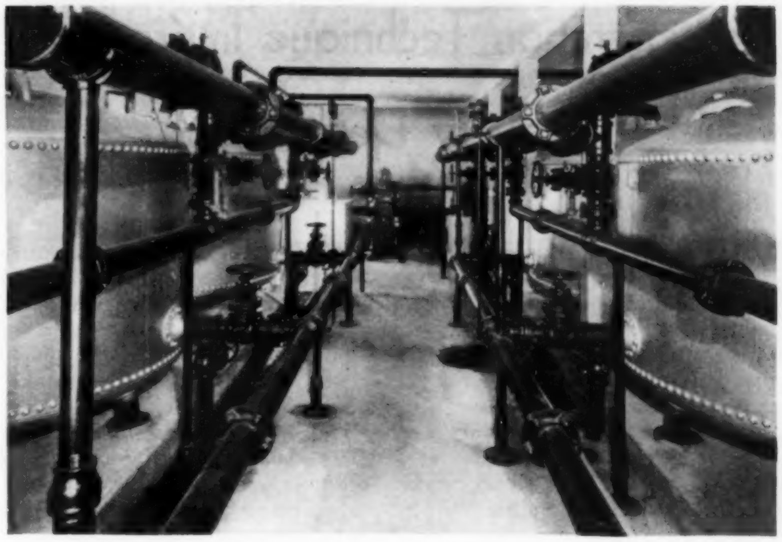


Fig. 2. Battery of Hydrodarco water purifiers

In sewage treatment, where the larger percentage of the chlorine consumed is used in oxidizing organic matter, powdered activated carbon has in many instances been found to adsorb organic matter in a degree that permits a substantial reduction in the chlorine requirement.

Among other important and interesting applications may be mentioned the decolorizing of sugars and syrups, the refining of animal and vegetable oils, purification of solvents used in dry cleaning, and preparation of chemical and pharmaceutical products. One of the most recent developments in which activated carbon definitely promises to become an effective means of purification is in air conditioning, for adsorption of toxic, obnoxious, and disagreeable odors.

Activated alumina having marked adsorption powers is now produced by Aluminum Co. of America. The new product is a partially dehydrated aluminum trihydrate which by a special process of activation has been rendered highly adsorptive to gases and vapors. It will adsorb 100 pct. of the moisture from gases and vapors and is capable of the selective adsorption of gaseous mixtures; it may be reactivated economically and repeatedly without impairing its physical form or adsorbent qualities; it is resistant to crushing and abrasion; it is supplied in sizes ranging from powder form to pieces approximately 1.5 in.

This material may be used for such purposes as purifying and drying air and other gases, selective adsorption of gases, recovery of solvents, and adsorption of gasoline and benzol. Also, it may be used for removal of water from liquids, for adsorption of substances in true or colloidal solution, as filtering medium, and as a catalyst.

Tower packings for chemical plants have seen several modifications in recent years. The double-spiraled Hexahelix (*Chem. & Met.*, Vol. 39, p. 76) packing block, developed to avoid segregation of flowing gas and liquid in a packed tower, is now obtainable from the U. S. Stoneware Co., which also produces two modified blocks with cylindrical instead of hexagonal perimeters, but using the full-radius and double full-radius spiral. The six-sided Hexahelix block is said to be preferable to the cylindrical form for most purposes, but the latter shape is preferred for special purposes by some users of tower packing. The cylindrical blocks are known as the Cyclohelix. A complete line of carbon raschig rings for tower packings has been developed by the National Carbon Co.

Separation Technique Improves In Every Department

UNDER the general heading of separation it is intended to discuss recent developments in filtration, screening, centrifugal separation, air separation, thickening and classifying, and magnetic separation. In not all of these fields have improvements been equally numerous. Filtration, perhaps, has been especially fortunate in that a considerable number of organizations have been active in sounding out its possibilities.

One important development of the period is the use of cake-compacting means on rotary vacuum filters. A belt weighted with rollers is employed by Filtration Engineers, Inc., and Arthur Wright, Inc., while Oliver United Filters uses a roll.

Filtration

A number of interesting filter applications have recently been made in the paper industry. Oliver-United has developed a new ground-wood decker, a rotary vacuum filter which operates with 80 per cent submergence and is said to increase decker capacity by some 20 per cent. Rotaries have also been applied in place of the diffusion pans in the washing of brown stock in kraft and soda-pulp mills. Still another application is in high density bleaching where the pulp is thickened on the filter to 6 per cent pulp content, then squeezed by means of a roll to 78 per cent water content.

Another of the recent developments of Oliver-United is the top-feed filter, a vacuum type in which no tank is used, the slurry being spread on the filtering surface by means of a feed trough placed above the drum. Rotation of the drum carries the cake under an air heater where the moisture content is brought as low as 0.5 per cent. This compares with a final moisture content of 3-5 per cent in older equipment.

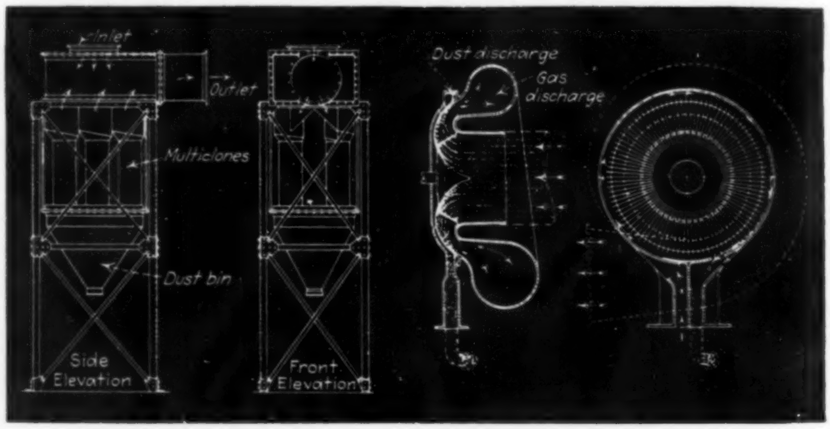
Two further developments are the Oliver-Beatty clarifier and the Oliver-Campbell cachaza filter. The former is a vacuum clarifier for liquids containing not over about 1 per cent of solids. It consists of a vertical, cylindrical tank containing a vertical shaft from which filter leaves radiate. Discharge is accomplished by sluicing. The cachaza filter is used in cane sugar mills for the filtration of hot, defecated cane juice. It resembles the standard Oliver in some ways, although it differs markedly in others. It employs a metallic cloth and a submergence of only 15 per cent. By the use of a double liquor port in the valve chamber, the first filtrate drawn as each section is submerged is separated for return to the filter.

Another vacuum filter of very different type is the new Bartlett-Hayward Genter filter which is formed from a vertical spider carrying a number of tubular filter elements, the lower ones of which are immersed in a feed tank. Motion of the spider is reciprocating and intermittent so that there is a shorter return motion for each forward movement, serving to agitate the slurry and give quick submergence.

One definitely new piece of equipment combines the characteristics of filtration and thickening. The Laughlin clarifier, which has been applied to the separation of sewage sludge in the Dearborn, Mich., municipal sewage plant, resembles a Dorr thickener in that it uses a circular concrete tank, a sludge rake and central sludge discharge for settled solids, a center feed well and a circumferential overflow for clarified effluent. Here, however, the resemblance ceases. Through an annular filter bed of magnetite particles, supported inside the overflow, liquid is forced upward by the hydrostatic pressure of the feed. A magnetic cleaner, moved by the sludge rake, rides over, agitates and cleans the filter bed continuously.

Screening

Among mechanically shaken screens, the most noticable development is the diversity of mechanisms that have appeared. Cams, ratchets, unbalanced rotors, electrical vibrators and centrifugal force are all employed. The Blutergess sifter, introduced by the Abbé Engineering Co., is a mechanical screen which differs from all others. Instead of a shaking or vibrating action, this device hurls the material to be sifted against the inside of a screen drum.

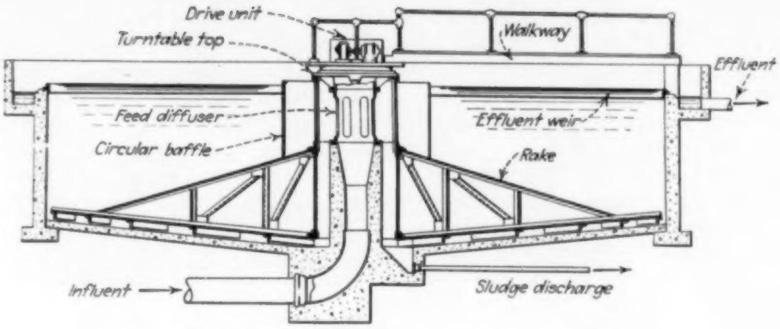


New air separator types: Western Precipitation Multiclone at left; American Air Filter's Turbo-Clone at right

The hurling mechanism consists of a turbine-type feeder which throws the particles outward by centrifugal force. Its capacity, in proportion to the space occupied by the Blutergess, is said to be much higher than in any other method.

Centrifugal Separation

So far as is known, only one centrifugal introduced in the United States during the depression period was radically different from all previous equipment. This is the Sharples Rotojector, a high-speed clarifying centrifuge which provides for semi-automatic discharge of separated solids while the bowl is rotating at full speed. An inner bowl slides within a casing so as to uncover an annular slot when solids have accumulated to sufficient extent. This movement is accomplished by the centrifugal pressure of water admitted to a special space in the bowl, which pres-



Dorr siphon-feed clarifier using round tank

sure works against a piston and opens the bowl against spring pressure.

The slow-speed centrifugal has been applied to a number of continuous clarifying problems. A number of types with imperforate baskets have been used in cleaning paper stock. Customarily, some of the stock is trapped behind a baffle, so that solids which are heavier than the pulp are driven into the mat of trapped stock and prevented from passing over the dam.

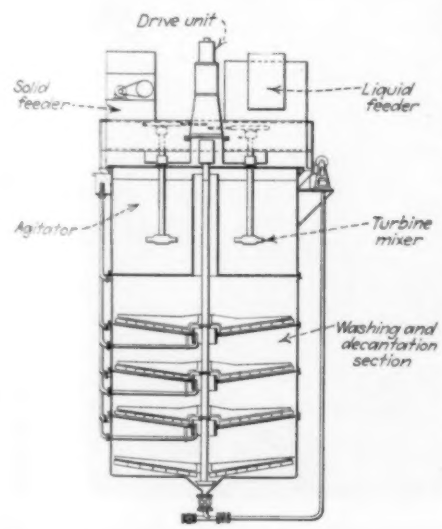
Air Separation

Progress in air separation has been made in three directions. Fan-operated equipment has been redesigned for closer separations; cyclones have shrunk to small-diameter devices, used in multiple; while what is called the dynamic separator, a centrifugal fan combined with a dust-skimming arrangement, has appeared on the market.

The small-diameter, multiple cyclone has been exploited by two concerns, the Western Precipitation Co. and the Prat-Daniel Corp. It has been found that the separation factor for a cyclone of small diameter is very much greater than for a large one. In commercial units, a collection efficiency of over 99 per cent has been obtained where the particle size averaged about 5 microns. As examples of use, the collection of boiler fly ash and of milk powder may be cited.

The third type of air separator mentioned above was introduced a few months ago by the American Air Filter Co., under the name of Turbo-Clone. Dust is sucked into the center of an impeller where it is deflected toward the periphery by a cone. It passes through a large number of hyperboloid blades, after which, as the stream follows the curved outline of the casing, the dust is skimmed off into an annular passage while the air continues on into a volute. On some dusts the collection efficiency is said to be as high as 99.5 per cent.

Complete reaction and C. C. D. plant built by Dorr



Thickening

Sedimentation practice has benefited in a number of particulars. One of the earlier developments of the period was a thickener brought out by the Dorr Co., for use with flocculent precipitates. It was noted that a gentle stirring action made for uniform flocs and hastened sedimentation. A cross-flow, circular basin which employs a number of vertical stirring bars mounted on the rake mechanism was, therefore, brought out to accomplish the desired result.

A still newer sedimentation unit is the Dorr Sifeed clarifier, a type of construction that can be applied both to the square traction clarifier and the round, central-drive clarifier. The outstanding feature of this new method is the introduction of the influent through a centrally located, inverted siphon, as appears in the accompanying drawing. In the central concrete pier is a vertical conduit, flared out at the top where it joins a feed-diffusing casting. This casting supports the clarifier mechanism. It is provided with a turntable top which, in the central drive type shown in the illustration, carries the driving mechanism. In the traction type, it carries the inner end of the oscillating drive truss. It also supports a large, circular baffle and the rake mechanism.

The siphon feed is said to give minimum turbulence and disturbance within the settling zone. Further than this, it is said to improve feed distribution. Other savings are in pumping cost for the feed and, sometimes, in the cost of the tank. In some settling problems, the new construction is said to have shown 30 to 40 per cent higher capacity than equal settling area in other types of equipment.

This company recently developed a combination reaction and settling device, comprising in itself a complete C.C.D. unit. This equipment consists of a vertical tank, in the upper part of which are four built-in reaction agitators equipped with turbine-type mixers, and below these are two to four thickener compartments for washing and decantation. On top of the tank are mounted a feeder for solid material and another for liquids. The unit has been employed for small-scale recausticizing and in the manufacture of alum solution. In the latter connection, the equipment is completely rubber lined and is capable of producing 5 tons of equivalent 17 per cent alum per day. Bauxite and acid are continuously fed to the first reaction compartment, overflowing in turn to the other three. From the last the slurry passes through the washing and decantation sections. In smaller sizes, the entire unit may be shipped assembled, ready for immediate installation and operation.

Classification

With the increasing use of closed-circuit grinding, classifiers of the Dorr rake type have become increasingly important. As a result, about two years ago, the Dorr Co. redesigned its Type D classifier, bringing out the F model. This eliminated the cam and roller mechanism for operating the rake by substituting eccentrics, cranks and linkages which give a much simpler design with about 22 per cent fewer moving parts. Very recently a similar rake mechanism has been applied in the F X classifier, the largest ever built. This permits a circulation as high as ten to one in closed-circuit grinding, with a capacity for the classifier of about three times that heretofore attempted.

Electrical Separation

Probably the most important recent development in the application of elec-

tricity to separation processes is the advent of the high intensity magnetic separator. The first installation of one of these machines was made in 1930 at the plant of the Tennessee Mineral Products Corp. at Spruce Pine, N. C. It was used in the production of ground feldspar for the manufacture of glass, a product which must be free from even very faintly magnetic materials. This machine employed a number of laminated rotors revolving under the pole pieces of two large electro magnets. Materials to be separated were connected in a thin, uniform stream over each of the rotors, one after another, giving them five stages of separation.

Since the development of the first machine, several concerns have adopted a similar principle. In each case a number of separation stages is employed, the magnetic element being two or more laminated rotors in which the magnetism is induced. More highly magnetic materials cling to the rotors a fraction of a second longer than the values, which causes them to drop into the tailings chute. It is stated that there are some 40 materials sufficiently magnetic to be separated by this means.

Heat Technology Turns to New Mediums

PERHAPS the outstanding tendency in heat application today, in all cases where high temperatures must be maintained, is to get away from direct firing of equipment and to substitute some of the new high-temperature heat-transfer mediums that have recently come into use. The best known of these new applications is probably the Sun Oil Co.'s mercury-vapor process for lubricating oil distillation. Mercury vapor for industrial heating is also being used in a number of other installations upon which it is not yet possible to publish information. In the field of power generation, much interest has been aroused in the Emmett mercury boiler which was originally developed at the plant of the Hartford Electric Light Co. Its principle has recently been used in the large new mercury-vapor plant built at Schenectady by the General Electric Co.

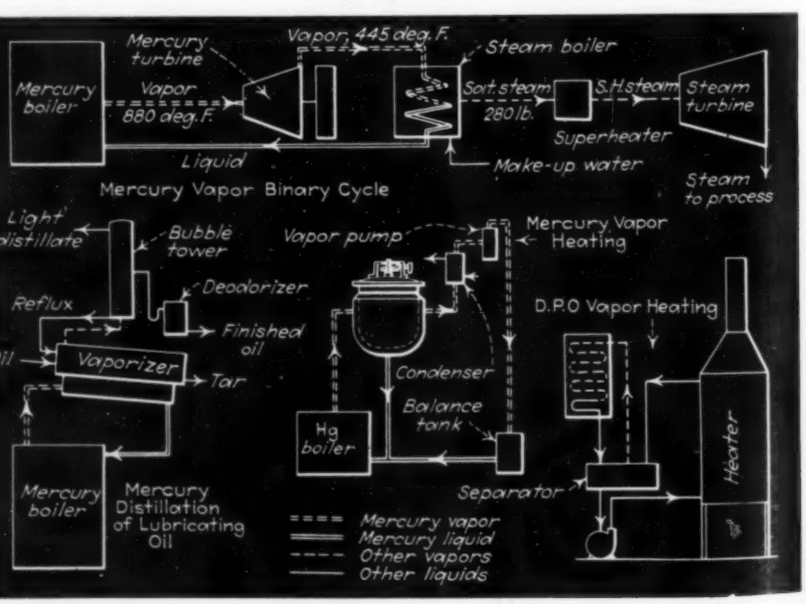
Other mediums are also much in evidence. A laboratory curiosity only a few years ago, diphenyl is now being produced on a commercial scale in considerable quantities for use in heat transfer. Diphenyloxide has also enjoyed similar success. A mixture of these two is being exploited by the Dow Chemical Co. under the trade name of Dowtherm, and this concern is itself using the mixture in a large number of high-temperature heating applications.

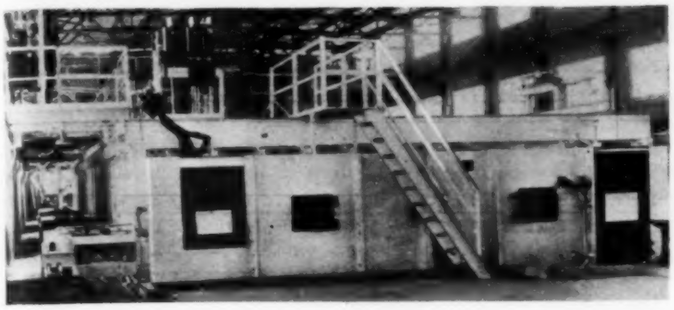
To return to the Sun Oil process, mercury is evaporated at a pressure of about 67 lb. and a temperature of about 850 deg. F. for use in a specially designed vaporizer. Topped oil, after neutralizing, is flowed in a thin sheet across the surface of a steel plate which slopes downward toward the discharge end. Vapors flash from the film of oil into a vapor space above the plate while mercury vapor is conducted into a second vapor space beneath the plate. As it condenses, mercury is returned through a trap by gravity to the boiler. Different sections of the vaporizer operate under different temperatures which are accurately controlled by the pressure of the mercury vapor. Oil vapor flashing from the plate is conducted to a conventional fractionating column, producing a middle product which requires no re-running and needs only a deodorizing treatment under vacuum, and dewaxing in the case of paraffine base crudes. At the high temperature of operation of the mercury boiler, a preheater is necessary to give suitable heat recovery. In this, combustion air is preheated to about 600 deg. with the result that the overall efficiency of the unit compares favorably with steam practice.

Aside from the mercury-vapor binary power cycle, there has also been some talk about the use of materials other than mercury in power generation. Most of these ideas hinge on the use of chemicals and involve the synthesis and breakdown of chemical substances so as to produce superheated vapor without actually making the vapor undergo the superheating process. With the vapor "born" at the top temperature, such cycles theoretically fulfill the requirements of Carnot efficiency in remarkable fashion.

In experimental work conducted at the University of Michigan, Badger developed equipment for employing diphenyl in the dehydration of caustic soda. He was able to carry 50 per cent solution to 98.2 per cent and is said to have eliminated all operating difficulties. There has also been talk of the use of mercury for this purpose.

Examples of mercury vapor and diphenyloxide heat-transfer systems, including the mercury-vapor binary cycle for power and process steam, the Sun Oil lube-oil process, and simple heating set-ups using mercury vapor and diphenyloxide





Electric heat-treating furnace for aluminum structural shapes, in use by Aluminum Co. of America

The Dow Chemical Co. has been active in promoting the use of the diphenyl-type compounds and has developed a number of methods for their use. For its own processes the company recently installed a Dowtherm heater operating at 50 lb. pressure, and a temperature of 661 deg. The heat output is 4,000,000 B.t.u. per hour, equivalent to nearly 500 lb. of coal per hour.

Compounds of the diphenyl type find their most important application in the range of temperature between about 600 deg. F., to which oil heating can be used, and about 750 deg. at which temperature employment of mercury becomes necessary. The fields of circulated oil and diphenyl compounds overlap in the range from 400 to 600 deg. There is also an overlap with mercury, which has been used at temperatures as low as 300 deg. F. and subatmospheric pressure.

Among the advantages mentioned for the diphenyl compounds are the facts that they are non-corrosive, non-poisonous and capable of withstanding high temperatures for long periods of time without undue decomposition. The eutectic mixture of diphenyloxide and diphenyl, which has a melting point of 56 deg. F., is frequently employed. It contains 26 per cent diphenyl and 74 per cent diphenyloxide. One of its most important advantages is that it is unlikely to freeze in the lines when the equipment is shut down. For all of these compounds the principal advantage, aside from the high temperatures obtainable, lies in the fact that these temperatures are attained at low pressure without the requirement for heavy and expensive equipment. No difficulty has been encountered in making this equipment tight. Joints should be welded, but welding of ordinary quality is satisfactory. The equipment, in general, is similar to that used for operation with steam except in so far as it must withstand higher temperatures. It is interesting to note that the cost of diphenyl-type vapors is not more than twice that of steam under similar conditions (Grebe, *Chem. & Met.*, p. 213, Apr., 1932).

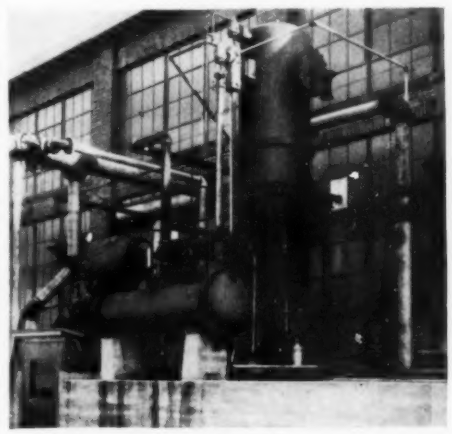
Electric heat, also, has made gains in both high and low temperature heating. Its field is being recognized and the factors determining its use in preference to other methods standardized. There are, of course, problems that cannot be met satisfactorily by any other means, such as the arc temperatures required in the manufacture of calcium carbide and abrasives. For other applications, electricity must compete on its merits, since the temperatures are not excessive. Recent examples are to be found in electric boilers operating on off-peak power; small electric steam generators for process steam required in amounts too small to justify a fuel-fired boiler; electrically heated lehrs now used quite extensively in the glass industry, and in other applications where atmosphere control, cleanliness, good working conditions, or similar factors are of importance. Kilns for chinaware, decorating tile, and enamelware have recently employed electric heating with beneficial results.

One interesting application of electricity is found in the use of induction heating applied to process vessels. This development has been described by Center (*Chem. & Met.*, p. 617, Nov. 1932) who states that it is simple and easy to control. It is not necessary to employ high-frequency current, in fact, in the installations described, the power used was 25 cycle, 220 volts, single phase. A heavy copper primary is wound around a cast iron or steel reaction vessel which, in effect, becomes the secondary of a stepdown transformer. The heavy current which flows in the vessel wall accomplishes the heating.

Future Looks to "Heat Pump"

Although it is evidently not widely practical at the present date, there has been a good deal of recent interest in the use of reversed refrigeration ("heat pump") for building heating. Electric power used in this manner is about four times as effective for low-temperature heating as it is when used with resistances. It has been stated that with current at 1 cent per kw.-hr., heating can be accomplished in this way at a cost equal to that with $15 coal. This figure, however, is based on domestic house heating and cannot be applied too closely in industrial practice. The interest in the method, of course, arises from the fact that the heating equipment is used for air cooling and dehumidification in the summer time.

Some of the most interesting work that has been done recently in connection with combustion is the investigation and application of diffusion combustion by the Surface Combustion Co. A glass furnace using this method is being erected in Toledo. The fundamental aim of diffusion combustion is to retard the rate of combustion as much as possible, by avoiding premixing of the gas and air and eliminating all effects tending to accelerate their mixing. Under such circumstances, combustion occurs through molecular interdiffusion and results in a flame which can be made to fill the combustion space completely and to give off the maximum amount of radiant energy (Williams and Cone, *Jour. A.C.S.*, Sept. 1932).



Foster Wheeler 75-ton vacuum refrigeration equipment for process cooling; condenser water is heated for process—refrigeration cost is therefore negligible

Diffusion combustion is accomplished by injecting into the furnace a stream of gas, surrounded by a stream of air, in proportions proper for complete combustion. Hence, combustion can take place only at the boundary of the two streams and only as rapidly as the gases can diffuse through the intervening layer of combustion products. This results in a maximum cracking of the gas hydrocarbons, with the generation of particles of carbon which, in burning, give a highly radiating, luminous flame capable of liberating heat at a substantially uniform rate throughout the entire length of the flame. When

this type of combustion is applied to a glass tank, it is said to give superior stirring by reason of the better control of convection currents in the bath, better temperature control, and lower actual furnace temperature. The low temperature differential required for heat transfer under the radiant conditions of the flame should, it is believed, increase the life of refractories very substantially.

Refrigeration

Probably the most important recent factor in the refrigeration picture is the rediscovery of the old vacuum refrigeration process. Within the past two or three years this has been quite extensively applied both to industrial refrigeration, when temperatures above the freezing point of water are required, and in air conditioning equipment. When water is admitted to an evacuated space, vapor flashes off at the expense of the sensible heat of the water until an equilibrium is established at a water temperature corresponding to the vacuum maintained. The vacuum producer in most modern vacuum refrigeration equipment is the steam-jet ejector which compresses the vapor so as to make the temperature of the condenser cooling water relatively unimportant. Water admitted to the flash chamber may be reduced to any temperature above 32 deg. F., although a temperature of about 40 deg. F. is generally considered the economic lower limit.

Several developments of interest have taken place in mechanical refrigeration. One of the most notable is the development of the new refrigerant, dichlorodifluoro-methane, which has the advantage of being non-toxic. This is a development of Thomas Midgley, Jr., and A. L. Henne.

In the production of water ice on an industrial scale, two recent quick-freezing methods have become increasingly important. One of these is the FlakIce machine of Crosby Field (Trans. A.I.Ch.E., Vol. 24, p. 16, 1930) in which thin sheets of ice are formed continuously on a revolving drum capable of deformation. The drum is formed of alternate bands of Monel metal and rubber. Brine circulates within the drum, which is itself submerged, except for its uppermost part, in water. A roller within the drum distorts it as it revolves so that the strips of ice which form on the Monel bands are continuously cracked off and discharged. Among the advantages of this method may be mentioned its quick-freezing and the production of ice flakes, having certain unique properties. Because of their slight curvature, the flakes are separated by air spaces when in storage and will not freeze together. Because of their relatively enormous surface, their refrigerating effect is quickly available.

Similar rapid freezing is the object of the Pak-Ice machine, a device in which rapidly circulating water is frozen continuously in a thin layer upon the inner surface of a corrugated drum, the outer surface of which is cooled by a brine jacket. The thin ice coating is continuously removed by a rotating scraper and the chips carried from the machine by the stream of water and separated by draining. Both this and the FlakIce machine are used to produce frozen brines for colder refrigeration.

Among other refrigeration developments may be mentioned the increasing tendency to employ multiple stage compression. The result of this is to diminish the power requirements and make possible a saving in cylinder volume.

Refractories and Insulation

Two tendencies in the modern use of refractories are to be noted: One is the development of better materials, while the other is to eliminate the use of refractories almost entirely, for some purposes. The latter is the case in modern steam-generating equipment where the use of water walls has the dual effect of making possible a greater heat absorption, while at the same time it ends refractory troubles.

At the beginning of the period under consideration, the mullite-base refractory was just coming into use. Remarkable results were obtained with cast mullite blocks in glass furnaces. Later, mullite was used in refractories for other purposes, including furnace walls.

Probably even more important is the advent of the insulating type of refractory. Several of these are now on the market. In general, they are composed of heat-resisting materials which contain numerous vesicles produced by chemical action. Another recent trend is in the direction of plastic and castable refractories, several of which have been introduced in the past few years.

The most striking of the new insulation materials is Alfol, an insulation consisting of air spaces bounded by crinkled and embossed sheets of aluminum foil. This material, surprisingly enough, has a resistance to heat transfer equal to that of the best cork, inch for inch, and yet it weighs practically nothing. It is unaffected by severe vibration, it is moisture-proof and it resists most industrial fumes and vapors. It has been used for the insulation of cold rooms, refrigerated cars, steam piping, boilers and diesel engine exhausts and is satisfactory from very low temperatures to about 1,200 deg. F.

Barnitt and Heilman (A.I.M.E. meeting at Pittsburgh, Apr. 13, 1931) have described the development and application of high-temperature insulating materials that have recently been produced from minerals consisting chiefly of aluminum oxide. Such insulating materials now appear in the form of Carey Alumino-Hi-Temp which is manufactured from monohydrated bauxite. Blocks of this material are suitable for furnace temperatures in excess of 2,000 deg. F., provided that the intervening firebrick layer holds the block temperature to 1,900 deg. F. The conductivity at this temperature is considerably lower than that of most commercial high-temperature insulators.

Heat Transfer

Among the newer development in heat-transfer equipment are several that should be mentioned. New forms of extended-surface tubing have been brought out, one interesting variety of which is made by Griscom-Russell. In this form, the fins are crimped into longitudinal slots in the tubing. The same company developed a type of two-pipe heat exchanger in which the heat is transferred from one pipe to the other through numerous sheet-metal fins.

Two "filter-press" type heat exchangers appeared. One of these is the Stamsvik, which consists of a number of recessed plates clamped together by means of through bolts and sealed with gaskets. Openings through the plates are so arranged that the assembled exchanger consists of a number of thin, substantially circular chambers separated by thin metal diaphragms. Somewhat similar is the Polyplate exchanger of Schutte & Koerting. The plates in this instance are so designed that the two fluid passages follow spiral paths, separated only by a thin spiral diaphragm.

Two concerns developed submerged heaters for use with gas. In each of these the gas flame burns in a pipe-like chamber which is installed beneath the surface of the liquid to be heated. This method is said to give an overall heating efficiency of over 80 per cent. Among other heat-exchange equipment there were a number of complete units, one of which was a flash-type exchanger for the recovery of heat from process fluids containing solids in suspension. Its maker, Foster Wheeler Corp., accomplishes this by the use of a flash evaporator in connection with a direct-contact heater which serves as a condenser.

Handling Equipment Improvement Meets Diversified Needs

HANDLING of materials, both solid and liquid, has always been an operation in which the elimination of hand labor offered attractive opportunities. As a consequence, several important new handling methods have become evident. Among those for solids is the Clark Twin-Veyor which is used for moving packages, bags or barrels into or out of storage. This equipment consists of a pair of parallel cylinders operating on bearings and carrying on their surfaces spiral flights which, when rotated in opposite directions, cause the package to advance rapidly along the conveyor. Short conveyor sections may be joined together in straight lines or around turns, either on the level or upgrade.

Vibration which is effective in producing movement only in one direction has been applied in the Traylor conveyor. Vibrating units are attached at an angle to troughs or other sorts of conduits so as to give a forward throw of controlled amplitude to the trough contents. Solid materials are delivered at speeds up to 50 or 60 ft. per minute and up any incline to 18 deg. These conveyors have been built also in the form of water-cooled tubes for the dustless handling of hot materials.

Another new conveying method is the spiral conveyor made by Hardinge. This consists of a tubular casting containing an integral spiral. Any number of tubular sections may be joined together and the whole rotated like a kiln so as to carry hot, dusty or abrasive materials forward in a dustless manner. Any number of feed and discharge points may be employed.

One of the most important developments in recent years for the bulk handling of solid materials over railroad lines is the Dry-Flo tank car developed by General American Transportation Corp. In appearance this resembles a standard tank car, but it employs an unloading mechanism consisting of an endless chain conveyor operating in each end of the car. The car adapted to the handling of all sorts of dry, pulverized solids and may be unloaded in the case of most commodities in less than two hours.

Another distinctly new handling development is found in the Redler En Masse conveyor manufactured in the United States by Stephens-Adamson Mfg. Co. This conveyor employs a trough in which continuous, quiescent flow of pulverized or granular solids may be induced much like the flow of water through a pipe. Fingers attached to a cable move the material as a mass and are capable of carrying it horizontally, vertically or at any angle. Still another bulk handling mechanism for solids is the Fluxo cement pump of F. L. Smidth & Co. By aerating cement as it passes through a special nozzle, it is possible to make it flow like a liquid, under air pressure. Consequently, the equipment is very much like a blow case in design and consists of one or two vessels into which the cement is sucked by vacuum, after which it is discharged by air pressure.

Liquid Handling

Equipment for liquid handling divides itself naturally into the three classifications of pumps, valves, and pipe and fittings. Several trends in pump design are notable. One of these is the recent tendency to supply automatic primers with centrifugal pumps. Another almost universal trend is toward close-coupled centrifugal pumps for small capacities. In these, the impeller of the pump is mounted on an extension of the motor shaft while the pump casing is attached to the motor end bell.

Pumps decidedly new in principle are not often seen. The DeLaval Steam Turbine Co. introduced a new type of rotary pump consisting of a spiral-threaded, central, power rotor meshing with one or more sealing rotors. Hence, the pump bears some resemblance to the screw pump, although only one rotor is driven while the others idle. Only one stuffing box is necessary, the liquid velocity is low, the flow is pulsationless, and operation is quiet, even at turbine or motor speeds.

Propeller-type pumps have frequently been employed in the past for handling large quantities of liquid under low head. This type, however, has poor no-load characteristics, which have been improved upon by the Foster Wheeler Corp. in the development of a new form of axial-flow pump which employs a propeller-like impeller, in conjunction with discharge vanes to convert the high flow velocity to static pressure and to direct the flow parallel to the axis.

Several important developments in connection with valves have been observed. To permit throttling without wire-drawing and cutting of the disk and seat, the Ludlow Multi-Valve employs a multi-contact valve plug which closes against a conical seat. The plug is conical in shape, but instead of having straight surfaces, it is provided with a number of grooves, so that in throttling the pressure is reduced successively through several stages.

Reading-Pratt & Cady introduced what is probably the first lubricated gate valve. Hills-McCanna developed a diaphragm valve for corrosive service which may be lined with rubber or produced from any workable metal. The closing means is a rubber diaphragm which is compressed by means of a mushroom disk against both the inlet and the discharge seats.

Improved operating means for remote-control valves have also been developed. One of these is the Thrustor operator, developed by the General Electric Co. The power unit is hydraulic, consisting of a propeller-driven piston in a hydraulic cylinder. The thrust is powerful but no limit switch is required since damage cannot result if the piston should over-run or if the valve should strike an obstruction. A second remote-operating development is the DeFlorez method of remote valve control. Two Selsyn motors are the operating means in this instance. One is geared up from a handwheel which may be turned by the operator, while the other is geared down to drive the valve. When the transmitting Selsyn is turned, the receiving motor turns equally so that the motion of the handwheel is duplicated at the valve. Automatic Temperature Control Co. has evolved a method of indicating at any distance the setting of a valve which has been adjusted, manually or automatically, by a motor-operated controller. To do so a transmitter sends current impulses to a dial-type indicator.

Among pipes and fittings may be mentioned the development by Guyton & Cumfer Mfg. Co. of a complete line of jacketed pipe and fittings for use in installations where steam or hot oil must be circulated around a line. Continental Diamond Fibre Co. has developed a line of fittings made of Dilecto. After much experiment the Corning Glass Co. has evolved a joint for Pyrex industrial tubing which is easily taken down and yet is tight against 50 lb. pressure, without the requirement of careful installation.

In addition to advances noted above there have also been improvements in liquid storage and transportation. To avoid standing losses of certain volatile liquids, such as gasoline, it is often desired to store them under pressure. To permit this to be done with a tank of minimum-weight construction, the Chicago Bridge & Iron Works designed the Hortonspheroid, which is built in the peculiar spheroidal shape which a rubber sphere, filled with a liquid under pressure, would assume. This natural form permits lighter construction than is possible with any other shape because the stresses arising from the weight of the liquid are at a minimum.

With the advent of nickel-clad steel a few years ago, General American Transportation Co., in cooperation with Lukens Steel and International Nickel, employed the material in the fabrication of nickel-lined tank cars for the shipment of liquid caustic soda, particularly to rayon manufacturers. Caustic makers had been able to produce the liquid with an iron content of no more than 0.0002 per cent, but there was inevitably some contamination in transit in iron cars, which had forced certain of the rayon plants to purchase fused caustic in drums. It was estimated not long ago that the saving to rayon producers from the shipment of liquid caustic amounted to about $8 per ton over the cost of the fused product. This economy the nickel-lined car permitted, with substantial savings for the industry.

Mixing Advances Despite Empirical Status

MIXING remains very much of an art, since it has been described as having the least scientific foundation of any of the unit operations of chemical engineering. The reason for this state lies not in any disinclination on the part of those who would reduce it to a science to employ scientific methods, but rather in the fact that the conditions are always so diverse that they have not as yet been subject to mathematical analysis.

Nevertheless, important improvements have been noted in each of the principal fields of mixing. In connection with the mixing of gases, some very informative experiments were reported by Chilton and Genereaux (Trans. A.I.Ch.E., Vol. 25, 1930 and *Chem. & Met.*, p. 755, 1930). These investigators set up a glass line within which the mixing of two air streams, one of which contained smoke for visibility, could be observed. Summarizing the results of the tests, the authors stated that with an ordinary T-connection, good mixing can be obtained provided that the mass velocity of the added stream is two to three times that of the main stream.

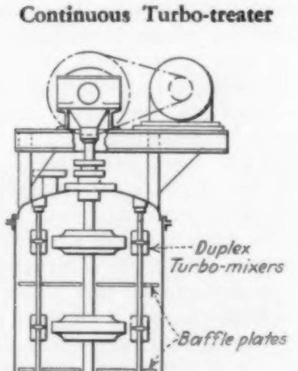
An interesting modification of an old idea is found in an epicyclic mixer that has recently been introduced into the United States and Canada by the Lancaster Iron Works. This is an American modification of the German Eirich mixer which has been given the name of Lancirick. Except for the ceramic industry, sales rights for this machine in the process field are vested in the Turbo Mixer Corp. The mixer is intended for dry and plastic materials and consists of two moving elements, a slowly rotating pan into which the ingredients are charged, and an oppositely rotating "star," or three bladed paddle, which is set off center in the pan so as to clear the edge only slightly. In addition to the star, two or more stationary, plow-like blades are used to scrape material from the edge of the pan toward the center. For some sorts of mixing, the star may be equipped with one or two rollers to impart a kneading, rubbing or coating action.

Lancirick mixer for dry and plastic materials

In the field of lighter mixing, most of the developments have occurred in connection with turbine-type mixers. New models have been brought out by both the Blaw-Knox Co., and the Turbo-Mixer Corp. The latter's Turbo-disperser is a very recent machine which is said to fill a place intermediate between the colloid mill and simple mixers. It consists of a centrifugal turbine impeller rotating within a screen or perforated plate which is interposed between the impeller and a series of stationary deflecting blades. A combination of rubbing action, extruding action, and a high rate of flow, is said to be the salient feature. The machine is intended for the making of dispersions such as oil and water, asphalt and water, and paint pigments in vehicle. For many kinds of paints and enamels it is reported that no premixer or stone mill is required.

The continuous-type Turbo-mixer, originally described in the April, 1931 issue of *Chem. & Met.*, has recently been modified by the addition of baffles between the several impeller stages so as to give the effect of several agitated tanks in series. As appears in the accompanying drawing, the new machine consists of a single tank divided into compartments, in each of which a duplex turbine unit operates. By thus interrupting the straight-line flow from inlet to exit, short-circuiting is prevented and the effect of several tanks in series is obtained. It may be pointed out that in a single stage of agitation on a continuous basis, equipment to handle 400 gal. per minute and give a 15-second treatment to 95 per cent of the material would have to have a capacity of 1,900 gal. On the other hand, by passing the material through three stages of treatment, the total capacity of the equipment would need to be only 230 gal. to accomplish the same results. In the first case,

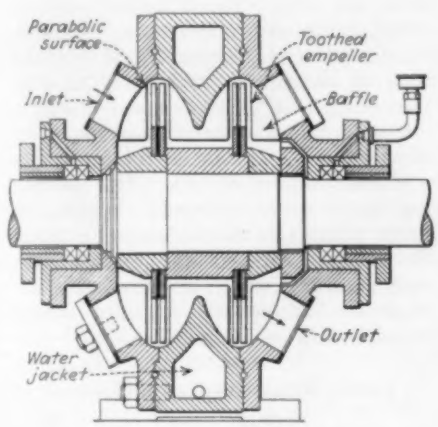
Continuous Turbo-treater



TECHNOLOGY ADVANCES

the 5 per cent receiving a shorter treatment would remain in the apparatus an average of 7½ sec., but in the second case, from 9 to 15 sec.

Another new mixing accomplishment of an entirely different type is found in the Dorr Co.'s Flocculator, a device which has been employed to improve coagulation in the treatment of water supplies. The Flocculator consists of one or more horizontal shafts placed across the coagulating basin, carrying paddles which sweep slowly toward the feed end of the basin at the bottom. The effect of this mild agitation is to build up the flocs produced by the chemical treatment to a uniform size which will settle readily and at a uniform rate. The equipment requires only about 6 kw.-hr. per million gal. treated and has, in one installation, decreased the consumption of alum by 40 per cent, or 2 tons per day. At the same time, on account of the increased settling rate of the floc, the run of the filters has been increased by 12 to 15 per cent.



Cross-section of Bethune mixer

Several new pieces of proportioning equipment have been introduced in recent months by Proportioneers, Inc., for use in continuous mixing operations. Fundamentally, this equipment consists of a small reciprocating-piston motor driven by air or water pressure. This operates some form of displacement pump, such as a piston, bellows or diaphragm, which is used to force the desired reagent into a line or mixing vessel. The stroking of the motor unit is controlled in various ways in proportion to the flow of the main fluid. One method is to control the valves of the motor unit by means of a meter or rotor measuring the main flow. Another is to move the valves back and forth through the movements of a reciprocating pump controlling the flow of the main fluid.

Something entirely new in mixing equipment has recently appeared in the United States. It is so new, in fact, that a complete appraisal of its possibilities is not yet possible. This is the mixer invented by G. S. deBethune, of Belgium. Although this equipment has been compared to the colloid mill in some of its features, Mr. Bethune states emphatically that it is not a colloid mill, either in principle or in construction. Briefly stated, the Bethune mixer has large clearances and accomplishes its mixing by repeated driving of the materials against especially designed surfaces which retard passage through the machine, while at the same time they cause a gradual advancement.

One form of the Bethune mixer, which has been somewhat modified in later models, appears in the accompanying drawing. The machine consists of a water-jacketed casing not unlike a centrifugal pump in appearance. Within the casing are two flat, toothed rotors which run with wide clearance between baffles set in the parabolic sides of the housing. These are not, as shown in the drawing, in the vertical plane, but set at an angle of 45 deg. to the vertical. Mixing results from the action of the rotor teeth against the particles which are driven centrifugally against the casing. Because the particles are impelled from a point near the focus of the parabola, they rebound from the casing in a direction substantially parallel to the rotor and are thus subjected to repeated contacts. In some of the later machines, the casing surface on the entrant side is parabolic, while that on the emergent side is hyperbolic so that the rebound has a small component toward the discharge. A second principal difference in later machines is the use of tangential instead of radial inlet and discharge.

Although the machine has occasionally been used for disintegration, its chief field is in rapid mixing and contacting prior to reaction. It has been employed in making emulsions, such as asphalt with water; and in the inducing of extremely rapid saponification and other reactions. As examples of specific performance, the following are to be noted: A single-rotor machine operating at 1,450 r.p.m. and passing 3,600 g.p.h. of water, consumed 3⅓ hp. The same machine, contacting 2,700 g.p.h. of oil and fuming acid, requires 6 hp. A two-rotor machine, treating an asphaltic emulsion at 1,500 r.p.m. and at the throughput rate of 1,050 g.p.h., required 13 h.p.

Among colloid mills proper, the improvements noted have been largely in the nature of refinements. U. S. Colloid Mill Co. developed a type of rotor suitable for the disintegration and dispersion of fibrous materials, while the Th. Goldschmidt Corp. introduced a new foreign emulsifying mill, called the Zenith. This equipment is said to employ a new principle, that of bringing the materials to be emulsified together at the point of maximum hydraulic shear and agitation. An impeller rotates in a casing, clearing stationary pegs in the casing wall by reason of slots cut in the blades. Emulsification results as material passes outward past the pegs.

Closer Control Becomes Requisite In Chemical Processing

MUCH INGENUITY, in recent years, has been displayed by the makers of control equipment in meeting the increasingly severe demands put upon them by chemical industry. Much closer temperature control, for example, has become necessary under the realization of the tremendously important effect of temperature on reaction rates. In addition, with increasing severity of reactions, instrument makers have been called upon to work with higher temperatures, higher pressures, and more corrosive conditions.

So far has control gone since *Chem. & Met.* examined it four years ago, that it is manifestly impossible to more than touch upon a few of its phases. In general, improvement has come about both because the problems are better understood today, and because the equipment itself has advanced markedly. Developments are to be noted in almost every line. Some of the most spectacular are to be found in the field of electron tubes, where the photo cell, with or without the assistance of other special tubes, has come near to accomplishing the impossible. Just as an example, the Thyratron tube has been used in controlling the speed of direct-current motors to maintain constant tension in web systems such as paper and rubber-

ized fabrics. With the addition of a photo tube, the motor has been made to respond to changes in color of process liquids. The photo tube alone now has many applications, including counting, routing of packages on conveyors, separating materials of different colors, sounding fire alarms, indicating breaks in paper, measuring smoke density and many similar applications.

New applications of other sorts of control have been numerous. For example the automatic control of stabilizing towers for gasoline has become important. For this purpose, Brown Instrument Co. has developed a trend-analyzing interlock control which records the vapor temperature and automatically shifts the control point of another instrument which measures the reboiler temperature and controls the heating medium. As time lag has made a special method necessary in this case, so it does also in tube-still control. The same concern has solved this problem with an instrument which measures and records the temperature of the hot oil leaving the still, while at the same time it controls another instrument which in turn responds to furnace temperature and controls the burner supply.

Automatic Temperature Control Co. developed an ingenious control for regulating the flow of latex. A time-cycle controller applies external pressure on a hose through which the latex passes, thus avoiding the expense of valves.

Many of the problems of the gas industry have yielded to automatic control. One of these problems is in gas distribution where varying demand makes satisfactory pressure regulation difficult. The Foxboro Co. has applied several types of controllers to this work, in most cases employing a sensitive pressure controller to move the lever of an ordinary gas regulator and produce the same effect as shifting the weight. Where the load demand varies in a predictable manner, a time cycle pressure controller is used similarly.

Improved Control Equipment

Such examples might be multiplied endlessly. However, space limitations make it necessary to pass to a discussion of the more recent instruments themselves. Those incorporating an anticipating or trend analyzing feature are among the most interesting. Time lag frequently makes them necessary to avoid the detrimental effects of hunting. The Stabilog controller made by Foxboro controls time lag and demand changes through the use of an invariable control point. Changing demand shifts the throttling range but maintains the control point constant. Swings are damped out and overshooting avoided. A somewhat similar result is attained by this company's Deoscillator which is used with a thermoelectric pyrometer, impressing a voltage on the circuit which opposes changes.

The DeFlorez potentiometer pyrometer, used with oil stills, similarly corrects for shifts in the control point. When the temperature wanders, the instrument integrates the deviations and at intervals, if necessary, resets the air-operated control system.

New flow meters have been particularly numerous in recent years. Of those that are used only for indicating, the Schutte & Koerting Rotameter and the Vulcan Copper & Supply Co.'s line of notch meters may be mentioned. The former employs a vertical glass tube of increasing diameter in which upward flow supports a float at a point proportional to the flow. The second type, much used in controlling stills, places a V-notch weir or slotted tube within a look-box. Both types are individually calibrated.

Tagliabue brought out a mercury-sealed flow meter using a mercury chamber of such shape as to give straight-line characteristics. Transmission to the recording mechanism is through a magnetic element. Brown developed the "area type" meter for viscous materials in which a movable gate orients itself at an elevation proportional to the flow, which elevation is transmitted to the recorder by an inductance bridge. Foxboro has applied the Stabilog to flow control and has also introduced a line of high-pressure orifice meters. Builders Iron Foundry developed the Oriflo orifice meter in which an inductance bridge in the manometer connects with a self-synchronous motor in the recording instrument. The same concern brought out the Chronoflo meter which can use any two wire system, including the telephone lines, for recording at a distance. A venturi or an orifice plate produces a differential pressure, dependent on the flow, which regulates the length of a recurrent electric contact and so, periodically, adjusts the recorder.

Several improved self-balancing potentiometers were introduced. Leeds & Northrup brought out the Micromax which greatly improves in speed on the old mechanism. New potentiometer mechanisms were developed by Brown, Foxboro, Wilson-Maeulin and Uehling. Tagliabue employed the photo cell in eliminating all mechanical tie-up between the galvanometer and the operating mechanism in its new potentiometer recorder.

An improved air relay, known as the Free-Vane has been used by Bristol in several of its instruments, including its temperature, differential temperature and pressure controllers. The vane is frictionlessly positioned between opposed air jets by the sensitive element. The quantity of air escaping from the jets controls a bellows which in turn moves an air valve and adjusts the control pressure on the diaphragm valve.

Developments in pressure measurement and control included two by Leeds & Northrup. These differ only in the matter of measuring the pressure, one using an automatically balanced scale beam to "weigh the pressure" and the other, a mercury manometer. Pressure transmission is accomplished in each case by a contact riding on a slide-wire which is part of a potentiometer circuit. Bailey transmits pressure indications to a distance with a pair of self-synchronous motors. The measuring means is an automatic dead-weight tester which sets the transmitting motor. Bristol has evolved an absolute pressure recorder, which automatically corrects for barometric pressure in the measurement of vacuum.

Level Recording and Control

Level measurement has several recent representatives. Foxboro has applied the Stabilog to level control so as to maintain either the level or the outflow of a tank, the latter coincident with holding the level within bounds. J. H. Bunell & Co. introduced the MacCreedy indicator, which measures levels to $\frac{1}{8}$ in. and transmits the measurements telegraphically to an indicator at any desired distance. Yarnall-Waring developed the Eye-line gage, a device particularly suited to the convenient indication of inaccessible levels. From one of its boiler-level indicators the company extends a tube through which runs a chain supporting a target exposed behind a gage glass.

Among miscellaneous equipment is the new line-current gas analyzer of Leeds & Northrup. This is of the thermal conductivity type and because it employs an alternating-current bridge, it requires no battery. Many new timers and programming contacters are in evidence including those of Bristol and Taylor which have been extensively employed in the rubber industry. Photo cells operating in conjunction with light sources placed on the other side of the stack have been used by Leeds & Northrup and Brown in the recording of smoke and fume density. They have also been used by Chatillon in an integrating conveyor scale and by Toledo in accomplishing automatic cut-off in several varieties of batching scale.

Modern Trends Apparent in Process Equipment

EQUIPMENT manufacturers, in common with other builders of capital goods, have joined the depression-accelerated race for increased economies, both in their own production and in the functioning of the machinery they build. In the first case, they have developed new fabricating methods; while in the second, they have studied process needs more closely and have designed for lower cost, better efficiency and less operating attendance.

The use of welding has become even more general as its possibilities have increasingly demonstrated their usefulness, as testing methods have advanced, and as the welded pressure vessel has received the sanction of regulatory bodies. Non-destructive tests have become more certain, while the application of X-ray and gamma-ray testing has received much attention, both from specialists and from the fabricators themselves. A double exposure with X-rays has made it possible to determine the exact depth of faults in welded construction, while X-ray equipment has been developed to a point where even 4-in. and thicker material presents no difficulties. With a new 300-kv. machine developed by St. John X-Ray Service, a 4-ft. diam. seam in 4-in. material can now be completely exographed in as little as 7 hours. With a new paper developed by the same company for use instead of film, film cost is halved and equally good results obtained.

Welding Methods Develop

Use of coated welding rods, within the past few years, has become much more general because of the superior protection which the coating gives to the deposited metal. New technique has been developed by Linde in the use of oxyacetylene welding in pipe lines. Air Reduction Co. has brought out a gas cutter for pipes which can make circumferential cuts as well as other profiles necessary in producing bends and connections.

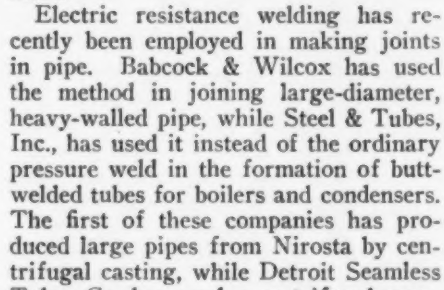
Application of hardfacings by welding has shown gains. Materials used now include Stellite, manganese steels and tungsten carbide, the latter mixed with alloys of tungsten, iron and carbon. The welding of piping has benefited from the development of standard weld fittings, which eliminated the need for the home-made contrivances previously used by welders to the detriment of both cost and the resistance and appearance of the line.

Aside from the use of the torch and arc welder, other new fabricating methods have come into use. Rolling mills are now producing ply-metals, consisting of a backbone of mild steel, faced on one or both sides with corrosion-resisting materials such as pure nickel and stainless steel. The advantage of a thin layer of corrosion-resisting material anchored to a stronger backing of a cheaper metal has been obtained by the Fansteel Products Co. in the fabrication of tantalum equipment by making a thin shell of this metal and then plating it with copper to give the necessary strength to the equipment.

Electric resistance welding has recently been employed in making joints in pipe. Babcock & Wilcox has used the method in joining large-diameter, heavy-walled pipe, while Steel & Tubes, Inc., has used it instead of the ordinary pressure weld in the formation of butt-welded tubes for boilers and condensers. The first of these companies has produced large pipes from Nirosta by centrifugal casting, while Detroit Seamless Tubes Co. has used a centrifugal process for lining and bonding to a tube of steel a corrosion-resistant layer which can be almost any non-ferrous metal or alloy.

To get down more specifically to process equipment not covered in the preceding articles, there have been many developments worthy of note. Several examples are to be found in the production of SO_2 from sulphur and pyrites. The Freeman flash-roasting process for pyrites fines was first used in the early depression years. From a ball-mill dryer, finely ground pyrites is blown into a combustion chamber from which the gases pass through a dust chamber and thence through a waste-heat boiler. Because of rapid cooling, very little SO_3 is formed, so that the recovery of sulphur is high. The cooling yields over 1 lb. of steam per pound of pyrites.

T.G.S. pressure burner for sulphur



Sulphur feeding and burning has shown improvement. In Merrimac's new vanadium contact plant a day's supply of sulphur is brought in on a special hopper car which feeds directly to an underground, brick-lined melting tank from which the sulphur is continuously withdrawn by means of a submerged, variable-speed plunger pump. Sulphur is fed continuously to the top of a checkerwork pyramid in the upper part of a firebrick-lined steel shell, where its complete combustion is supported by dried air. Any sulphur which is still unburned at the bottom of the pyramid trickles over a second pyramid placed below the first.

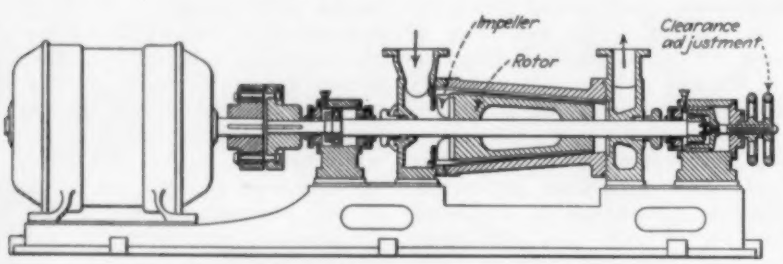
Burning Sulphur Like Oil

Texas Gulf Sulphur Co. has developed a burner for molten sulphur which has a capacity of about 13 tons of sulphur per day. Among the advantages claimed for it are: Gives a constant-strength gas of as high as 19-20 per cent SO_2, over a wide range of capacity; forms no SO_3 and permits no sublimation; easy to regulate, operate and shut down. The burner has a steam-jacketed nozzle in which compressed air is the vaporizing means. Sulphur is supplied under pressure by a turbine-driven centrifugal pump, the speed of which is controlled by a gas-recorder that adjusts the turbine steam valve. Combustion takes place in a cylindrical firebrick-lined chamber in which are baffles and checkerwork partitions to break up the stream and insure complete burning.

Certain machinery developed in other process industries is of considerable interest here. In paper mills the Wiener refiner (Dorr Co.) has been showing remarkable results in breaking up the fiber bundles, reducing the fiber length to the desired size, and in loosening the molecular structure so that the fibers are properly hydrated. This equipment bears some resemblance to the jordan, but is more nearly like a colloid mill. It consists of a grooved, tapered rotor rotating on a horizontal shaft within a similarly grooved and tapered housing. Clearance is adjusted by a handwheel. Pulp is fed in at the large end and forced through the refiner by means of an impeller attached to the rotor. The opposing tendencies of the rotor and impeller put the pulp under considerable

pressure so that in its passage it is subject to violent disintegrating impacts, alternately under fluid pressure and partial vacuum.

Refiners have been used on sulphite and kraft stocks, on groundwood, sulphite and sulphate screening, on shredded wood and in defibering waste papers. They are stated to have shown a power saving, over other refining equipment, of $1.50 per ton, together with increased capacity of the paper machines of 25 to 30 per cent and a 25 per cent reduction in beater-room labor.



Cross-section of Wiener refiner for pulp

De-airing Clay

Probably the most notable development of recent years in the ceramic industry has been the advent of the de-airing process for plastic clays. As early as 1902 there seems to have been a recognition of the fact that the presence of air between the particles of clay leaving the pug mill was responsible for various difficulties, including the development of exaggerated laminations during extrusion, blistering, warping and failures in drying. Although two or three plants resorted to de-airing as early as 1927, in the main, the industry appears to have paid little attention to the process until about two years ago. About that time the Bonnot Co. developed a commercial de-airing machine and Ohio State University, in cooperation with this company, conducted an extensive research, which has established many facts in support of the new technique (Ohio State Eng. Exper. Sta. Bull. 74).

Among other things, it was found that in no case was de-airing harmful in any way, but that in every case improvement in working properties was a result. The effect of de-airing is similar to that of prolonged aging. In every case, there was a marked increase in both tensile and compressive strengths, while drying failures were reduced and the usable drying temperature increased. Further than this, materials that formerly could not be used with the stiff mud process could be so used after de-airing, while shapes that were heretofore impossible with this process yielded on de-airing. In many cases lower temperature firing was possible with resulting properties at least equivalent to those obtained without de-airing.

The first application of de-airing in the manufacture of chemical stoneware has been made recently in the plant of Maurice A. Knight, at Akron. Its application produces an unusually homogeneous clay mass which makes possible the production of finished ware of high strength and density, and superior uniformity. Laminations, crevices and pinholes are eliminated, and it is possible to make very material reductions in the wall thickness of wares.

The remarkable working properties and rubbery character of de-aired clay are well demonstrated by the accompanying view taken in the Knight plant. It shows the extrusion of a 3-in. pipe with a Bonnot de-airing machine. In tests it has been found possible to produce a one-piece cooling coil with a ½-in. wall and 3-in. bore, which, if straightened out, would be 112 ft. long. Formerly this coil was made in sections from 8 to 12 ft. long, with a ¾-in. wall. It has become possible through de-airing to reduce the wall thicknesses of pipe and fittings as much as 50 per cent, depending on size and usage.

The Bonnot machine, briefly, consists of a charging hopper which leads into a pugging chamber. From the latter the clay passes into a disintegrating chamber, where it is broken down so that in the evacuating section which follows most of the air is removed under a vacuum of 25 to 28 in. The clay is then compressed by an auger and extruded through a suitable die.

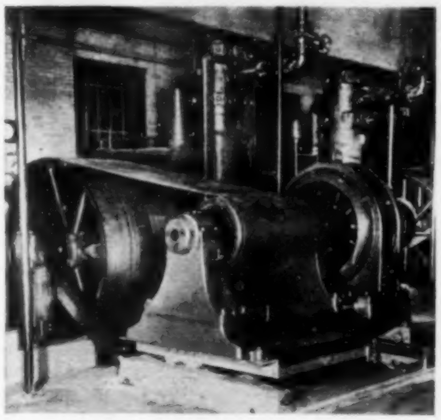
Power Transmission

Many developments are to be noted in the field of power transmission equipment. Although for a time it appeared that the inroads being made by direct drive were so great as seriously to threaten the belt, the trend has recently been checked under the influence of intensive belt research. The frictional value of leather belting has been increased, particularly with mineral retan varieties. Rubber belting has been improved over the folded type by the application of raw-edge construction. What is probably the outstanding development in rubber belting is the compensation of plies to eliminate separation.

Graton & Knight Co. has developed a tension-cementing method for the preparation of waterproof leather belting. The pyroxylin-base cement, in the form of sheets, is applied between the plies which are then subjected to tension and pressure. E. F. Houghton & Co. has brought out a new belt, Vim-Tred, which has a ribbed surface to concentrate the pressure between belt and pulley and thus increase the gripping power of the belt. A great many manufacturers have developed V belts for which pressed steel sheaves have been introduced.


Improved workability of clay through de-airing is shown by the extrusion of this 3-in. I.D. pipe in the plant of Maurice A. Knight, at Akron

One important movement is toward the use of the tension-compensating motor base for short-center belt driving. In this the motor acts as a counterweight on the belt. The Rockwood drive, for example, supports the motor on a pivot so that any desired part of its weight is borne by the belt. Even when the belt tends to stretch under load, the tension remains constant and at a minimum, just sufficient for the required service. This drive has been employed for the transmission of 450 hp. on 72-in. centers with a pulley ratio of 4 to 1. Similar results are attained in a somewhat different manner by the Alexander Bros. drive, in which the motor platform is supported on two half gears, which rest on racks in such a manner that the motor, in dropping slightly when the belt stretches, also moves away from the driven pulley, thus maintaining constant tension and uniform traction.



400-Hp. Rockwood drive on an air compressor

Probably the most far-reaching advance in power transmission in recent years is the development of the motorized speed reducer. The acceptance of this equipment is such that there is now scarcely a speed-reducer manufacturer and hardly a motor builder who is not offering it. In one small unit it combines both the power source and the reducer, eliminating the bed plate, the coupling and the separate reducer. It is manufactured in sizes from fractional to 75 hp. and in ratios from 10:1 to 125:1. Below 15 hp. the cost of the combination unit is less than that of the separate reducer, motor, bedplate and coupling while, above, it is somewhat more costly. The reducers used for such service are of three types, those employing one or two helical gear reductions, or a helical, planetary system of gearing, for parallel, horizontal drive; and those with a worm-gear unit for drive at right angles to the motor shaft.

Although it is not as generally applicable as the fixed-ratio reducer, the variable speed drive has developed intensively in the last few years. At the onset of the depression period, the Reeves, Llewellyn, J.F.S., Revocentric, Driscoll and two or three hydraulic transmissions were the only ones in general use in the United States. Early in the period, Reeves modified its standard drive to make possible automatic or remote control, later introducing a fully enclosed design. Link-Belt brought out a fully enclosed P.I.V. gear, made under British patents. The P.I.V. employs two variable-diameter pulleys of the opposed-conical-disk type, but instead of a belt in frictional contact with the pulleys, uses a steel belt crossed by numerous thin metal fingers, held in the belt so as to be able to slide endwise and mesh positively with radial grooves cut in the disks.

Another development of about the same period was the motorized J.F.S. transmission of Stephens-Adamson. This variable reducer was not new at the time, but the combination of reducer and motor in a single housing is believed to have been the first of this now growing family. Shortly thereafter, Reeves brought out the Varidrive pulley, a much simplified modification of the Reeves type for comparatively light drives. Instead of using two pairs of conical disks, the positions of which were positively adjusted to control the driving and driven diameters, the Varidrive uses a single pair, forced toward each other by a spring. The belt is of the side-drive type, but in addition has a bearing surface on its inner side for contact with an ordinary, flat, driven pulley. Adjustment of the speed is accomplished by moving the motor base backward or forward so as to cause the belt to bear on a larger or smaller diameter of the disk pulley.

New Variable Drives

Within recent months, several new variable drives have appeared. The Johnson, made by Smith Power Transmission Co., is of the over-running clutch type, using as the variable means a variable-throw crank. The Stanley Speed Variator is a new modification of the old friction-disk drive in which driving rollers mounted on radial shafts can be slid in or out so as to bear on a larger or smaller circumference of a pair of driven disks which are forced toward each other by spring pressure. Like the J.F.S. and the U.S. Varidrive, the Stanley has its motor built into the drive housing. The Varidrive, made by U.S. Electrical Mfg. Co., returns to the belt and variable-diameter pulley idea, but in a new guise. On an extension of the motor shaft are two opposed, conical, disks, which are spring loaded to serve as the driving pulley. The output shaft carries a similar pair of disks so mounted that their distance can be varied by turning a handwheel. As the driven diameter is changed, the driving pulley automatically adjusts itself to a new diameter which will maintain constant belt tension.

Electrical Equipment

Many advances in motors and other electrical equipment have been made in recent years which can only be touched upon here. In small motors for use in the plant, there is a decided tendency to use the totally-inclosed, fan-cooled type. Such motors are dust-proof, and some of them are explosion-proof. One recent motor, developed by Louis Allis, is splash-proof without being totally inclosed. The motor is ventilated and its splash-proof characteristics developed through the use of baffles in the end bells.

Motor controls have made progress. Arc quenching devices other than oil are being applied increasingly, for example, the type in which the arc heats a column of air and blows itself out almost instantaneously. A variation of this idea appears in the Westinghouse boric-acid fuse chamber in which the arc formed on melting the fuse wire is immediately extinguished by a rush of water vapor evolved from the walls of the chamber by the heat of the arc. There is a growing tendency to do away with fuses entirely and employ small breakers in their stead. To guard against overheating in motors Westinghouse has recently made use of a thermostatic disk which effectively shuts down the motor when its temperature goes above the point for which the windings have been designed.

Even in so brief a reference to electrical developments there must be some mention of the present state of the photo cell. It is now available in many styles of relay unit, generally comprising in combination a photo cell, a light source and a relay. The Weston Photronic cell, a development of the period, employs a sensitized disk which, under the action of light, generates a voltage proportional to the intensity of the illumination, and sufficient to trip a mechanical relay. This cell requires no separate current source. It has been used for many purposes similar to those of the photo cell, and in addition, in illumination meters used in improving industrial lighting.

Brewers Find Changes Among Construction Materials

Placing filter mass in position in a heavy cast bronze filter. Wort strainers are of copper sheet — bronze pumps impel the wort and beer through various stages

AN INDUSTRIAL Rip Van Winkle has reawakened after 13 years of sleep to find many changes have taken place. On April 7 the brewing industry found that rapid strides had been made during the long period of inactivity, in new methods, equipment, and construction materials. A few breweries had operated on a somewhat reduced scale, but many others had been dismantled. And while beer was only legal in 14 states in 1920, it has already been made respectable in 30 and others are expected to follow before many weeks. As previously abandoned and new breweries are equipped for action, tons of copper and brass, long a favorite material with the old brew masters, is being fabricated into kettles, filter presses, and pumps. In big headlines the daily newspapers have just announced an order from one brewery for 17 enamel-lined storage tanks, which if placed end to end would dwarf the Empire State Building. The stainless steels, unknown to the industry of other years, are coming in to use. Already we hear much of its advantages for floating cooperage, mash tuns, lauder tanks, and fermenting tanks. And with beer's return to respectability there should be a noteworthy demand for all of these materials.

And in recent years many changes have taken place among the materials of construction in other process industries. A rubber lining that would not soften and go to pieces in the presence of a mineral oil; enamel linings that may be repaired if damaged; a mild steel "clad" with nickel or stainless alloy, metallized wood, and "bonded" metal have all become available. And the newest and possibly most interesting feature is the chemical industry's own contributions to the field of materials of construction, plastics and synthetic resins.

Chrome-nickel steels became firmly established in the process industries since the start of the depression. Large quantities of these corrosion-resisting alloys have been employed by the heavy chemical, petroleum refining, and pulp and paper industries. The sulphite division of the last-mentioned industry has been particularly active in the uses of these metals. Its technical society has adopted recently a specification covering the chemical composition which it has found by trial to be best suited to resist the corrosion of the sulphite liquors. This branch of the industry is interested because of the possibilities of using stainless steel in place of acid-proof brick as a permanent digester lining, which would permit continuous operation without the costly shut-down to replace brick linings now necessary.

Advantages of Stainless Steels

As Wallace Johnson has pointed out, eliminating the brick linings and using a thinner metallic lining the capacity of the vessel would be increased at least 6 per cent; this would permit a material reduction in the quantity of steel used in a digester of equivalent capacity. Furthermore, replacement of brick with a smooth steel surface would reduce friction, permitting a lower pressure for emptying the digester, which in turn would reduce the quantity of sulphur dioxide forced out with the chips, resulting in a saving in chemicals. Chrome-nickel steels are used for many other pieces of equipment that constantly come in contact with sulphite liquor, such as piping in circulating lines, glands, strainers, and digester necks.

These high-strength steels are demanded to meet the rigid and severe requirements of the higher temperatures and pressures in the production of synthetic chemicals and in the hydrogenation of petroleum.

Later, when the demand for increased economy made it more difficult to get appropriations for expensive equipment the ingenuity of the alloy manufacturers was called upon and the "clad" steels were developed. The pioneer in this development was Nickel-Clad, mild steel covered with a thin layer of nickel. Introduced in 1931 after extensive joint research effort by the Lukens Steel Co. and the International Nickel Co., this material was brought out specifically for tank cars desired by the rayon industry for transportation of caustic soda free from copper and iron. This product was soon followed by chrome-nickel and other alloy clad or two-ply metals, such as IngOclad, developed by the Ingersoll Steel and Disc Co.

In the clad-steel plate the chemical engineer has available a useful and economical material for the fabrication of large and heavy equipment in which the employment of the more resistant alloy is most desirable, but where formerly the higher cost of the nickel or stainless alloy was a bar. The fact that the price of the new metal is about one-half of that of the solid alloy opens up an entirely new field for corrosion-resisting alloys.

Other corrosion-resisting alloys have been developed and made available to the chemical engineer in the past two or three years. One of the newest is Duriclor, the high-silicon iron just an-

nounced by the Duriron Co. This alloy is particularly interesting because of its resistance to hydrochloric acid of all concentrations and at all temperatures up to the boiling point. Durichlor is comparatively inexpensive. It is being used to make pumps, valves, pipe, jets and other equipment.

In 1932, announcement was made by the H. H. Robertson Co. of the development of a "bonded" metal, a metal base to one or both sides of which is attached a suitable felted material by aid of a metal adhesive. The felt of the resultant laminated material was then saturated with any suitable medium, such as asphalt, oil, or resin, to produce a waterproof and corrosion-resistant felt. The process need not be confined to the coating of flat shapes, and this product can be made resistant to heat and fire as well as to corrosion. Other advantages include increased insulating value compared with bare metal, sound-deadening properties, and the great strength imparted by the metal core.

Sterling Silver

Silver was formerly used in a limited quantity in chemical operations, such as the manufacture of pharmaceuticals and foodstuffs. Its use declined, however, both because of the high price and the development of many other useful metals. But the rapid fall to a record low in price of this metal again brought it within the reach of the chemical engineer, and, accordingly, industrial uses have grown again rapidly, especially in England and on the Continent. Recent installations in this country have been confined to foodstuffs, pharmaceuticals, and dye plants.

Acetic acid corrosion has frequently been combated with silver, both in condensation equipment in acid manufacture and solvent recovery in acetate rayon. Distillation of phenol, especially the purer grades, has also called silver into service, and condenser coils made of this metal have long been used in certain chlorination processes, particularly in the fine chemical industry.

The rubber industry, and in that term is included synthetic rubber and substitutes, although adversely affected by the price of crude and the curtailment in the automobile industry has been very active. Several new products have come out of the laboratories in 1931 and 1932.

For years Mr. Edison had endeavored to find a source of the raw material in this country which would save us from embarrassment in case of a national emergency. But practically nothing was heard of the development that was quietly going forward in southern California. In the early months of 1931, a representative of *Chem. & Met.* was invited by the Intercontinental Rubber Co. to Salinas, Monterey County, Calif., where he was shown rubber being produced on a commercial scale from the locally grown guayule shrub.

On Nov. 2, 1931, the engineers of the E. I. duPont de Nemours & Co. announced the results of extensive investigations that had led to the development of a new synthetic rubber, Du Prene, made by controlled polymerization of chloroprene. This rubber was not developed nor was it expected to compete with plantation rubber, but it has many important applications. The advantages of Du Prene are high resiliency; resistance to moisture, acids, oxygen, and most solvents, as well as to softening by heat.

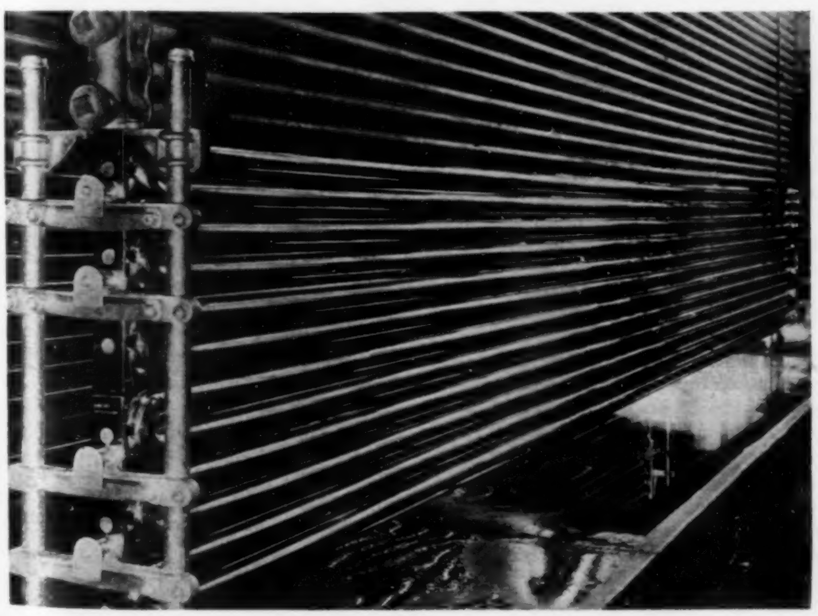
A short time later came the interesting announcement of a rubber substitute, a polymethylene polysulphide, then in production at Yardville, N. J. The features of Thiokol are its physical properties, and its resistance to such materials as petroleum products and volatile solvents.

Rubber Linings

Recognizing certain distinct advantages and certain limitations in each type of rubber, hard and soft, for chemical service, technologists of the Goodrich Tire and Rubber Co. have produced a construction which successfully combines the two types. In this construction, a layer of hard rubber is cushioned between two layers of soft rubber. This combination can be bonded to steel and certain other constructional materials, and finds its chief application in lining tanks and other equipment. A liquid solution of rubber which may be sprayed or brushed on interior surfaces, thus forming a protective lining, has been gaining favor principally because it may be applied in the plant of the user.

Advances have been made in several other materials. Glass sections for towers are now blown in diameters as large as 24 in. Six such towers were installed during the past year in a chemical plant for a distillation process. Another interesting development of the Corning Glass Works is the new joint for glass tubing, perfectly tight and easy to assemble and take apart. Among the recently developed coatings is a non-volatile synthetic drying oil, S-D-O, that may be applied to almost any surface except glass and enamel. Already it has made many friends. In the April issue of *Chem. & Met.*, Haveg, the synthetic resin equipment produced by the Haveg Corp., that has been in use in the process industries of European countries for several years and that has only recently been introduced to our American manufacturers, was described. The past few years has also witnessed the introduction of carbon equipment in the sulphuric and phosphoric acid, pulp and paper, and other industries.

Two surface (Baudalot type) ammonia beer coolers in Kings Brewery, Brooklyn, N. Y. First stainless steel coolers of this type in brewery service



High resistance to tarnish and corrosion, together with favorable mechanical properties and malleability, is claimed for new alloy, Inco Chrome Nickel.

NEWS FROM WASHINGTON

By PAUL WOOTON
Washington Correspondent of Chem. & Met.

INDUSTRY is at a fork in the economic road. It may choose voluntary cooperation or it must bow to government compulsion. That this is the choice first became evident from the address of President Roosevelt before the Chamber of Commerce of the United States, May 4.

Formerly it appeared that wage protection, working-hour limitations, and other regulatory measures were to be forced on industry. These were most clearly shown, and their terrifying implications exhibited, in the proposals of Secretary Perkins. The regulations so presented were even more sweeping than the initial thirty-hour week law which they supplanted. They had tacit Presidential sanction, but never formed officially an administration measure. They now lie on the table, with the concurrence of the author, but are by no means discarded.

The Presidential definition of the minimum acceptable cooperation plan was expressed in three gracious "requests": (a) "Refrain from further reduction in wages . . . . increase wage scales in conformity with and simultaneous with the rise of the level of commodity prices . . . ." (b) Correction "of unfair methods of competition, of cutthroat prices, and of general chaos . . . ." by working together "to prevent overproduction, to prevent unfair wages, to eliminate improper working conditions." (c) "Translate industry welfare into the welfare of the whole, ... view recovery in terms

EDITORIAL INTERPRETATION OF THE

Inflation

Inflation is definitely an objective believed necessary by the Administration. There is recognized a greater need for frequent turnover of money than for mere increase of money in circulation. However, cheapening of money and credit will be used to compel renewed activity, if mere frequency factors do not suffice to stimulate buying.

Major inflation projects rode as passengers on the Farm Bill omnibus. The first provision expected to be used is virtual compulsion on the Federal Reserve Board to enlarge open-market transactions, potentially to a $3 billion total. Failure of such program to secure desired results is provided against in the authority granted to use new paper money issues as an escape from curtailed credit and slow money usage.

Greatest consternation accompanied the dual provision providing free coinage for limited amounts of silver and partial devaluation of gold, down to 50 per cent of the present legal value, if the President deems it necessary. Both these provisions are generally regarded as essentially weapons for international conference trading in London about mid-June. However, the Administration may be successfully pressed to the point of accepting both, giving a quasi-monetization of silver and a 50-cent gold dollar.

One general consequence is a public debt, or equivalent public liability, approaching $30 billion within the next 18 months.

Farm Relief

Three weapons have been forged for attacking farm troubles: (a) Aid with Federal credit for farm-mortgage refinancing. (b) Crop and animal-product curtailment to increase market prices. (c) Industry agreements under the Secretary of Agriculture to regulate business all the way from raw materials to the ultimate consumer reached by agricultural products and their derivatives. Process Industries are concerned with both methods (b) and (c).

For seven basic agricultural materials and their derivatives, the Secretary of Agriculture is to be authorized to contract with producers for reduced output, paying them rental for idle land or bonuses for reduced animal production. The cost to the Treasury is to be assessed against the primary processers of these materials.

By industry agreements independent of crop curtailment, the Secretary of Agriculture under this pending legislation can virtually regulate businesses either directly or indirectly affected. Even leather, rayon, casein industries, for example, would be subject to potential agreements as they utilize farm materials. Agreements would be enforced by licensing of units of the industry or trade and might extend even to retail merchandise licensing. Almost certainly they would include wholesale licensing and chain-store supervision to prevent price cutting with loss-leaders and like evils. Process Industries are certain to be indirectly affected, and will be directly involved if an extended agreement program eventuates.

It was first proposed to use sugar as the original test case. At present, canned milk seems a more likely scapegoat to try out the program.

Muscle Shoals

A "Tennessee Valley Authority" is unquestionably to be established. At least experimental production of fertilizers will be required. Final decision remains as to commercial production up to 10,000 tons of nitrogen contained per year for at least three years. The House wants this; the Senate demurs. Power production by Government agencies is assured. Power marketing plans differ in House and Senate bills at the time of writing. Some new Government-owned lines seem likely. Much broader authority is included in the bill for retiring marginal land from agriculture, for reforestation, for economic and industrial development of mineral resources, for general betterment of the Tennessee River watershed.

Possibilities of combining reforestation with recreation features exist. Employment of present residents whose land would be taken over is suggested as essential, hence the recreation features. Departmental executives recognize the difficulty of new industry development. Congress does not worry about that. The new Authority will have to do that worrying, and decide about it. Policies will depend much on the judgment of the three $10,000 per year directors.

Tariff

Tariff changes, generally downward, may be expected. These are more likely, however, from international trading at London and through bilateral treaties to be negotiated by the President, than through new legislation. The Administration program thus far includes no tariff bill. But it is expected that the President will insist on gaining from this session of Congress authority to amend existing tariffs, by at least as much as 50 per cent of prevailing rates, as a part of his negotiating authority. If Congress insists on reserving the right of approval, or at least a veto within sixty days after pronouncement of such changes, the Administration will find this an obstacle to effective bargaining. It seems likely that the bargaining tariff idea must be accepted in the United States, as all the rest of the world uses it.

Stimulation of foreign trade to absorb agricultural surpluses and restore active commerce is a vital part of the Administration program. The methods to be followed are still obscure, presumably because they must be confidential until negotiations at London are well under way.

of the nation rather than in terms of the particular industry . . . . lay aside special and selfish interests to think and act for a well-rounded national recovery." These are not easy terms, but may be far more acceptable than those of the compulsion program.

An integral part of all ideas of extensive industry cooperation is the pledge that the Government will support the efforts. The President says, "I can assure you that you will have the cooperation of your Government in bringing these minorities to understand that their unfair practices are contrary to a sound public policy."

Every industry can write its own rules subject only to the supervision that inevitably will be exercised by the Government to protect the public interest. It may be inferred that the administration will sanction particularly that cooperation which has for its object the elimination of selling below cost. This close approach to price control is apparently deemed essential to protect wage scales.

Under the Perkins' plan, it looked as though Washington was to be a huge laboratory for amateur social and economic experimentation. Even some of the laws already enacted would give that opportunity. And the administration boys who were expected to play with the new legal toys resembled a gang of youngsters with a new chemical set from Santa Claus. Naturally, industry of all sorts looked with apprehension on such a possibility. The cooperation program gains greatly in attractiveness by comparison.

Experienced industry leaders, presumably organized under trade association plans, will be in charge. This looks much better than direction by people who without practical experience were to be qualified merely by their transfer to official position. Decision as to workable groupings of companies and definitions of each "industry" must be reached soon.

Process industry leaders must soon face these issues. Unfortunately a decision on major problems may have to be made with only partial factual basis as regards taxes, tariffs, and other vital subjects discussed below.

ADMINISTRATION'S RECOVERY PROGRAM

Taxes

Administration representatives claim that the Federal operating budget is already balanced. This claim assumes economies from curtailment of Federal expenditure, and by Government reorganization, as well as continued taxes on gasoline, electric light and power, and the new taxes on beer. It also assumes that the Government will care for all extraordinary expenditures either by new security issues to form a part of the public debt, or by such issues amortized or cared for shortly through new special taxes. Farm relief measures are to pay their own way by special charges against the process industries. Public works will be set upon a self-liquidating basis to some extent but this principle will not be permitted to interfere with a large program.

The Administration has not yet announced any new tax measures. The Administration policy is one of postponement of that issue for the present. It is an obvious hope that business may improve materially before any new tax burdens are suggested to discourage it.

Government Reorganization

Extended authority for reorganization is in the hands of the President. Some think that major changes of this character cannot be promulgated during this session of Congress. The authority of the executive does not extend to abolishing or creation of new major departments. Transfer and abolishing of bureaus and merging or realignment of independent establishments, including readjustments under new types of assistant secretaries, are authorized.

Some economy by cut in Government wages has already been accomplished. Further cuts in expenditure for Government pay rolls will be by furlough without pay for many workers. An average cut of 20 to 25 per cent in pay rolls is likely, compared with the fiscal year before last. (Last year the cut was 8⅓ per cent.) A great many Government workers are still likely to lose their jobs. The economy resulting from all this may be a few hundred million, but not enough to accomplish the promised 25-per cent cut in the gross spending of Uncle Sam.

Food and Drug Law

New authority in food and drug regulation is to be sought of Congress. The Food, Drug, and Insecticide Administration finds very sympathetic attention both within the Department of Agriculture and in the Presidential office. It thinks this time appropriate not only to secure legislation, but also to add new forms of authority more recently proposed. A bill including at least six major items is in preparation. It is expected to go to Congress soon but probably will not receive any consideration until the winter session.

The most striking, most discussed, new proposal is that Federal authorities have the same right to supervise advertising of foods, drugs, insecticides, and cosmetics, as they now have over labels and container markings. This now includes authority to seize goods improperly labeled; the proposal would give authority to proceed in the courts against manufacturers (and perhaps periodicals) indulging in improper advertising. Censorship desires are denied; "supervision" only is wanted.

Cosmetics containing poisons would be regulated out of existence according to a fourth legislative proposal. Toxic depilatories, dangerous constituents of lipstick, and other drastic and unsuspected drugging by cosmetics would fall under this ban.

As a sixth new, important amendment, the Department wishes the Secretary of Agriculture to have definite authority to fix legal standards. Now the authority in this regard is limited to the definition of standards for which separate legislation has been enacted; canned goods for example. All foods should be subject to this proviso, it is claimed.

Alcohol in Gasolene

Proposed is a Federal requirement of progressive increase in alcohol admixtures in motor fuel. Farm backers ask one per cent this year, 3 per cent next year, and 5 per cent by volume beginning 1935. The object is non-food usage of corn. Compulsion is to be by increase in the Federal tax on those motor fuels not complying with these alcohol limits, an extra cent per gallon immediately, 2 cents next year, and 3 cents later. Present indications are a joint Congressional investigation by Senate and House members during the summer.

Commodity Prices

A major objective in the administration program is re-employment based on increased commodity prices. The theory is that higher prices insure greater buying power and renewed industrial activity. Chemical process industry will be affected to some extent directly, invariably indirectly, by the artificial boosts in prices of basic agricultural materials, by confidently expected rises in the price of metals, and by the general price increase which must follow any acceptance of the President's demand for increased wages.

Where huge stocks of materials are still hanging over markets, the movement occasioned by inflation is, of course, slow. Despite all artificial stimuli, the influence of supply and demand still enters. Whether one commodity will move ahead or lag behind general price changes may determine the advantage or the danger of this phase of inflation for each individual manufacturer. Speculation in commodity futures perhaps promises to be the most dangerous and unpredictable cause of variation of an individual commodity from general trends.

Phosphoric Acid Business Attracts New Interests

TWO NEW interests enter the phosphoric acid business through changes in corporate ownership having large significance that occurred late in April. Monsanto Chemical Works secured a controlling interest in the Swann Corp. Oldbury Electro-Chemical Co. bought the blast furnace and chemical business of Coronet Phosphate Co. and will operate this as Pembroke Chemical Co. with manufacturing headquarters at Pembroke, Fla. Under their new managements the two phosphoric-acid furnace enterprises will constitute with Victor Chemical Works a trio of independent agencies attacking the problems of this important fertilizer chemical.

Monsanto's purchase of the Swann enterprises affords a logical expansion of the Mid-Western ventures which have made Monsanto a constantly growing part of the chemical business. The new Southern subsidiary is to be operated independently with Theodore Swann continuing as major executive. Since there is relatively small duplication of industrial activities between the older operations and the newly acquired subsidiary, extensive technical reorganization is not indicated.

Official announcements have not as yet been made by the Oldbury management as to the policy to be followed in their newly organized Florida property. F. A. Lidbury will be president. The German interests through Metall-Gesellschaft continue to hold the same minority interest formerly held.

A. S. M. E. Arranges Program for Chicago Meeting

AMONG the meetings scheduled to be held in Chicago during the week beginning June 26—Engineering Week of the Century of Progress Exposition—is the semi-annual meeting of The American Society of Mechanical Engineers. Headquarters will be at the Palmer House. The Process Industries Committee is continuing the work initiated at the National Process Meeting held in 1932 and at the coming meeting will furnish a program of five papers, two of which will carry on discussion of subjects already under consideration and the other three will bring up subjects not previously taken up by the committee.

Among the papers to be delivered at the Process Division sessions are: "Relation Between Pulverizer Capacity, Power, and Grindability" by R. M. Hardgrove, Babcock & Wilcox Co., and "Characteristics & Mitigation of Industrial Dusts" by J. M. Dalla Valle, Asst. Sanitary Engineer, U. S. Public Health Service.

Also "Mechanical Development in Municipal Sanitation" by W. Raisch; "Factors and Problems in Conditioning, Cooking and Pressing Cotton Seed Meats" by Prof. W. R. Woolrich & E. L. Carpenter; and "Effect of Vacuum on Working of Clay" by H. R. Straight.

Du Pont Cellophane Patents Licensed to Sylvania

AS AN aftermath of recent patent suits which attracted wide attention it is announced that the Sylvania Industrial Corp. has taken a license under the Du Pont Cellophane Co.'s patents for the manufacture and sale of moisture-proof regenerated cellulose.

The Tubize Chatillon Corp. has acquired by outright purchase from the New Jersey Zinc Co., Inc., all American, Canadian, English and European patents issued to James A. Singmaster, pertaining to the delustering of artificial silk or rayon by the use of pigments.

Notice of appeal has been filed in the U. S. District Court at Baltimore by the Electro-Metallurgical Co. of New York, subsidiary of Union Carbide & Carbon Corporation, and the American Stainless Steel Co. of Pittsburgh, in their infringement suit against the Rustless Iron Corporation of America.

Chemistry's Loss, Harvard's Gain

Prof. James B. Conant to Harvard Under-grads, Major J. B. Conant to Chemical Warfare, and plain "Jim" Conant to brothers in Alpha Chi Sigma and to "organikers" the world over—will become on June 22, by official decree of the board of overseers, Harvard's next president. With the congratulations and best wishes of the whole chemical profession, he assumes his new duties about Aug. 1. President James Bryant Conant, we salute you, sir!

Manufacturing Chemists Will Meet June 1

Announcement has just been made that annual meeting of the Manufacturing Chemists' Association will be held at Buckwood Inn, Shawnee on the Delaware, Pa., on June 1. In addition to the business sessions, the program provides for papers dealing with the present chemical and national situation.

Electrochemists Meet At Montreal

THE Electrochemical Society held its spring meeting, May 11-13, at the Hotel Windsor, Montreal, Canada. On the opening day two sessions were held, devoted to the electrochemistry of solutions. The speakers included Ernest A. Le Suer who discussed the development of alkali manufacture and D. F. Calhane and C. C. Wilson who spoke on the formation of organic nitro compounds. At noon there was an informal discussion on "Flotation" with Dr. O. Maass of McGill University presiding.

On May 12 an entire session was given over to discussions on the electric furnace with Prof. Alfred Stansfield of McGill University in charge. George O. Morrison and T. P. G. Shaw gave detailed accounts on the manufacture of ethylidene diacetate and vinyl acetate.

May 13 was devoted to an excursion to Shawinigan Falls, to inspect the factories in that vicinity.

Three important awards were announced at the close of the meeting. The Edward Goodrich Acheson medal goes to Dr. Colin G. Fink, the Edward Weston Fellowship for 1933-4 to R. D. Blue of Indiana University and the Society's annual prize to young authors was given to Frank W. Godsey, Jr., for his paper on the electrolytic condenser.

Dr. John Johnson, director of research, U. S. Steel Corp., was elected president. Other officers are: vice-presidents: Prof. Hiram S. Lukens, Philadelphia; E. F. Cone, New York; and S. G. Blaylock, Trail, B. C. Managers; S. D. Kirkpatrick, New York; O. W. Storey, Madison, Wis.; and T. F. Bailey, Alliance, Ohio. Dr. C. G. Fink and R. M. Burns were re-elected secretary and treasurer, respectively.

A complete technical report will appear in *Chem. & Met.* next month.

Pulp and Paper Engineers Visit Savannah

AS GUESTS of the Georgia Forestry Association and the Chamber of Commerce, a group of pulp and paper engineers from many parts of this country and Canada visited Savannah the week of May 1-6. The visitors witnessed the production of newsprint from the Southern pine trees in the semi-commercial laboratory of the Georgia Experimental Pulp and Paper Plant and inspected the vast forest areas adjacent to Savannah, where they became acquainted with some of the kindred industries that might supplement the paper-making activities. A more extended account of this development will appear in the June number of *Chem. & Met.*

Chemical Production and Distribution On Increasing Scale

REPORTS current in the market for chemicals agree that there has been a substantial upturn in demand since the turn of the month. Withdrawals against standing contracts have reached larger totals and inquiry in the spot market has been more active. Industries, which in recent months had materially reduced takings of chemicals were prominent on the buying side of the market. Producers of rayon who cut down manufacturing activities in March and April were again restored to a full-capacity basis and the pick-up in steel, rubber, paint, varnish, lacquer, and other trades had a wholesome effect on the movement of chemicals and other raw materials.

This has resulted in an about-face as far as production of chemicals is concerned. Based on consumption of electrical energy, there was a decided downward trend to the outputs of chemical plants. The revised index for production in March is 106.8 while operations in April show a further drop to 104.0. In some cases plants were reported to have cut down productive rates because of surplus stocks caused partly by limited consuming demand and partly by the failure of contract holders to order out deliveries in anticipated volume.

Rising Trend of Prices

An outstanding feature in the market in the last month has been the rising trend of prices. Starting on the theory that inflation would bring about higher price levels, grains, metals, and other raw materials began to appreciate in value. The movement spread to other markets including chemicals. With the upturn in prices came a substantial increase in buying orders partly due to the changed price situation but mainly because of larger consumer buying. In the case of grains, speculative influences undoubtedly aided the rise in values but in the case of chemicals the improved state of the market was due to larger orders from industries which previously had been taking far less than their usual quotas. For instance, recent buying for account of the fertilizer, steel and metallurgical, tire, automotive, and glass trades has surpassed expectations. Vegetable oils have advanced sharply in price with weighted index higher than at any time since August, 1931. As different lines which are consumers of chemicals and oils are sold ahead on their finished products, the prospects are favorable for a continuance of firm prices.

The Tariff Commission has set May 22 as the date for a hearing in connection with its investigation of production costs for plate glass here and abroad. It also announces that the hearing on phosphates and apatite scheduled to be held May 22 has been postponed until June 5 at the request of the respondents.

Nitrate of Soda Plans

Division of the present Nitrate Corporation of Chile into three concerns, the Anglo-Chilean Consolidated Nitrate Corporation, the Lautaro Nitrate Co. and a new National Nitrate Co., comprising the remaining producing properties, is contemplated by the Chilean Government in solution of the problems of the industry there, according to dispatches from Santiago. It is expected that a new sales agency will take over world distribution for the three concerns, buying the nitrate at cost plus $1.50 per ton. Two-thirds of the tonnage is to go to the Anglo and Lautaro units and the remainder to the government property.

Profits from the operations of the sales corporation will be divided among the government and the producers, who will take their operating profits from the $1.50 per ton, according to the plan. The sales profits will be divided 25 per cent for the government for revenues and 75 per cent for service on bonds of the producers. The present charge of $7.50 per ton of nitrate for bond service will be eliminated. The effect of the plan is again to destroy the 95 per cent monopoly Cosach has had in Chile.

For some time reports have been current about development of sources of supply for sodium sulphate in Chile. It is now stated that the Anglo-Chilean Consolidated Nitrate Co. recently completed its drying plant at Maria Elena, which has a capacity of 7,000 tons per month of sodium sulphate to be recovered as a byproduct from Chile nitrate operations. By removing most of the water from the sodium sulphate the operators expect to effect sufficient saving on freight to enable them to sell at a price advantage in other markets.

It is reported that the liquidating commission of Cosach is attempting to find markets abroad for sodium sulphate and that 1,250 metric tons were sold in Sweden and surveys of the American market have been made.

Incidentally charges involving the assessment of duty on imports of sodium sulphate into this country appear to have been over-ruled as customs officials have been ordered to liquidate entries on which action had been suspended.

New Insecticide Ruling

Apples worth at least a million dollars are virtually in quarantine in the Yakima and Wenatchee districts of Washington. Before release into interstate commerce they must prove that lead residues on the skins from sprays used for pest control are so small as not to constitute a hazard to public health.

The Department of Agriculture has also ruled that a new standard for lead permissible on all classes of foods is to apply to the production during the season 1933. Assistant Secretary Tugwell issued an order on April 2 announcing that not only apples but all other food would have to meet the limitation of 0.014 grain of lead per pound to avoid seizure, effective with the products shipped from the 1933 growing season.

An entire change in insecticide demand may result. There is even some talk about synthetic organic insecticides to replace lead arsenate. Entomologists say we do not know enough yet to permit any forecasts of feasible effective spray procedures of that sort. But new insecticide competition seems a certainty by 1934, though not prospectively important this year.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	84.80
Last month	84.30
May, 1932	85.44
May, 1931	88.62

A rising trend to prices for chemicals was fairly general. In some cases this brought the trading basis nearer the quoted levels and in other instances quotations were actually advanced. Deliveries gained in volume and added to the price firmness.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	52.37
Last month	42.01
May, 1932	40.40
May, 1931	68.29

Vegetable oils, fish oils, and animal fats recorded substantial price advances in the last month. Domestic products led in the upward movement with smaller advances in values for foreign oils. Buying was stimulated by the price movement with some cutting down of surplus stocks.

CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to May 15.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.08½-$0.09	$0.08½-$0.09	$0.10 -$0.11
Acid, acetic, 28%, bbl., cwt	2.65 - 2.90	2.65 - 2.90	2.65 - 2.90
Glacial 99%, tanks	8.89 -......	8.89 -......	8.89 -......
drs	9.14 - 9.39	9.14 - 9.39	9.14 - 9.39
U. S. P. reagent, c'bys	9.64 - 9.89	9.64 - 9.89	9.64 - 9.89
Boric, bbl., lb	.04½- .05	.04½- .05	.04½- .05
Citric, kegs, lb	.29 - .31	.29 - .31	.32 - .33
Formic, bbl., lb	.10 - .11	.10 - .11	.10 - .11
Gallic, tech., bbl., lb	.55 - .60	.50 - .55	.50 - .55
Hydrofluoric 30% carb., lb	.06 - .07	.06 - .07	.06 - .07
Latic, 44%, tech., light, bbl., lb	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18° tanks, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -......	18.50 -20.00
Oxalic, crystals, bbl., lb	.11 - .11½	.11 - .11½	.11 - .12
Phosphoric, tech., c'bys., lb	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton	15.50 -......	15.50 -......	15.50 -......
Tannic, tech., bbl., lb	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb	.20 - .21	.20 - .21	.24 - .24½
Tungstic, bbl., lb	1.40 - 1.50	1.40 - 1.50	1.40 - 1.50
Alcohol, ethyl, 190 p'f., bbl., gal	2.53½-......	2.53½-......	2.53½-......
Alcohol, Butyl, tanks, lb	.095-......	.113-......	.113-......
Alcohol, Amyl			
From Pentane, tanks, lb	.143-......	.143-......	.182-......
Denatured, 190 proof			
No. 1 special dr., gal	.34½-......	.34½-......	.34½-......
No. 5, 188 proof, dr., gal	.38½-......	.38½-......	.35½-......
Alum, ammonia, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags, cwt	1.25 - 1.40	1.25 - 1.40	1.25 - 1.40
Iron free, bg., cwt	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb.	.02½- .03	.02½- .03	.02½- .03
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb	.15½- .15½	.15½- .15½	.15½- .15½
tanks, lb	.05 -......	.05 -......	.05½-......
Ammonium carbonate, powd. tech., casks, lb	.08 - .12	.08 - .12	.10½- .11
Sulphate, wks., cwt	1.15 -......	1.00 -......	1.25 -......
Amylacetate tech., tanks, lb., gal	.135-......	.135-......	.16 -......
Antimony Oxide, bbl., lb	.07½- .08	.07 - .08	.06½- .08
Arsenic, white, powd., bbl., lb	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs, lb	.10½- .11	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	63.00 -65.00	63.00 -65.00	63.00 -65.00
Nitrate, cask, lb	.07½- .07½	.07½- .07½	.07 - .07½
Blanc fixe, dry, bbl., lb	.03 - .04	.03 - .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt	1.75 - 2.00	1.75 - 2.00	1.75 - 2.00
Borax, grain, bags, ton	40.00 -45.00	40.00 -45.00	40.00 -45.00
Bromine, cs., lb	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.50 -......	2.50 -......	2.50 -......
Arsenate, dr., lb	.05½- .06½	.05½- .06½	.05½- .06½
Carbide drums, lb	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton	17.50 -......	18.00 -......	18.00 -......
flake, dr., wks., ton	19.50 -......	21.00 -......	21.00 -......
Phosphate, bbl., lb	.07½- .08	.07½- .08	.08 - .08½
Carbon bisulphide, drums, lb	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb	.05½- .06	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb	.01½-......	.01½-......	.01½-......
Cylinders	.05½- .06	.05½- .06	.05 - .06
Cobalt oxide, cans, lb	1.15 - 1.25	1.15 - 1.25	1.25 - 1.35

	Current Price	Last Month	Last Year
Copperas, bgs., f.o.b. wks., ton	14.00 -15.00	14.00 -15.00	13.00 -14.00
Copper carbonate, bbl., lb	.07 - .16	.07 - .16	.07 - .16
Cyanide, tech., bbl., lb	.39 - .44	.39 - .44	.39 - .44
Sulphate, bbl., cwt	3.25- 3.50	3.00 - 3.25	2.75 - 2.90
Cream of tartar, bbl., lb	.14½- .15	.14½- .15	.19½- .20
Diethylene glycol, dr., lb	.14 - .16	.14 - .16	.14 - .16
Epsom salt, dom., tech., bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.70 - 2.00
Imp., tech., bags, cwt	1.35 - 1.40	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb	.08½-......	.08½-......	.10 -......
Formaldehyde, 40%, bbl., lb	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal	1.10 - 1.20	1.10 - 1.20	1.10 - 1.20
Refined, dr., gal	1.80 - 1.90	1.80 - 1.90	1.80 - 1.90
Glaubers salt, bags, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb.	.10¼- .10½	.10¼- .10½	.10¼- .11
Lead:			
White, basic carbonate, dry casks, lb	.06 -......	.06 -......	.06½-......
White, basic sulphate, sck., lb.	.05½-......	.05½-......	.06 -......
Red, dry, sck., lb	.07 -......	.06¾-......	.06¾-......
Lead acetate, white crys., bbl., lb.	.10 - .11	.10 - .11	.10 - .11
Lead arsenate, powd., bbl., lb	.09 - .13	.09 - .13	.10 - .14
Lime, chem., bulk, ton	8.50 -......	8.50 -......	8.50 -......
Litharge, pwd., csk, lb	.06 -......	.05¾-......	.05¾-......
Lithophone, bags, lb	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb.	.05¾- .06	.05¾- .06	.05¾- .06
Methanol, 95%, tanks, gal	.33 -......	.33 -......	.33 -......
97%, tanks, gal	.34 -......	.34 -......	.34 -......
Synthetic, tanks, gal	.35½-......	.35½-......	.35½-......
Nickel salt, double, bbl., lb	.11 - .11½	.11 - .11½	.10¾- .11
Orange mineral, csk., lb	.09½-......	.09½-......	.09¾-......
Phosphorus, red, cases, lb	.42 - .44	.42 - .44	.42 - .44
Yellow, cases, lb	.28 - .32	.28 - .32	.31 - .32
Potassium bichromate, casks, lb.	.07 - .08	.07 - .08	.08 - .08½
Carbonate, 80-85%, calc. csk., lb	.05¾- .06	.05 - .05½	.05 - .06
Chlorate, powd., lb	.08¾- .08½	.08 - .08¾	.08 - .08¾
Hydroxide (c'stic potash) dr., lb.	.06¾- .06¾	.06¾- .06¾	.06¾- .06¾
Muriate, 80% bgs., ton	37.15 -......	37.15 -......	37.15 -......
Nitrate, bbl., lb	.05½- .06	.05½- .06	.05¾- .06
Permanganate, drums, lb	.16 - .16½	.16 - .16½	.16 - .16½
Prussiate, yellow, casks, lb	.16½- .17	.16½- .17	.18½- .19
Sal ammoniac, white, casks, lb	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	16.00 -18.00
Soda ash, light, 58%, bags, contract, cwt	1.20 -......	1.20 -......	1.15 -......
Dense, bags, cwt	1.22½-......	1.22½-......	1.17½-......
Soda, caustic, 76%, solid, drums, contract, cwt	2.50 - 2.75	2.50 - 2.75	2.50 - 2.75
Acetate, works, bbl., lb	.04¾- .05	.04¾- .05	.05 - .05½
Bicarbonate, bbl., cwt	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb	.044- .05	.044- .05	.05 - .06
Bisulphate, bulk, ton	14.00 -16.00	14.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb	.03¾- .04	.03¾- .04	.03¾- .04
Chlorate, kegs, lb	.05¾- .07½	.05¾- .07½	.05¾- .07½
Chloride, tech., ton	12.00 -14.75	12.00 -14.75	12.00 -14.00
Cyanide, cases, dom., lb	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb	.07 - .08	.07 - .08	.07½- .08
Hyposulphite, bbl., lb	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt	3.25 - 3.40	3.25 - 3.40	3.60 - 3.75
Nitrate, bags, cwt	13.45 -......	1.295-......	1.77 -......
Nitrite, casks, lb	.07¼- .08	.07¼- .08	.07¼- .08
Phosphate, dibasic, bbl., lb	.018- .02	.018- .02	.0255 - .0275
Prussiate, yel. drums, lb	.11½- .12	.11½- .12	.11½- .12
Silicate (40° dr.) wks. cwt	.70 - .75	.70 - .75	.70 - .75
Sulphide, fused, 60-62%, dr., lb.	.02¾- .03½	.02¾- .03	.02¾- .03
Sulphite, crys., bbl., lb	.03 - .03¾	.03 - .03¾	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -......	18.00 -......	18.00 -......
Chloride, dr., lb	.03½- .04	.03½- .04	.03½- .04
Dioxide, cyl., lb	.06½- .07	.06½- .07	.06½- .07
Flour, bag, cwt	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb	nom.-......	nom.-......	nom.-......
Oxide, bbl., lb	.37½-......	.29½-......	.26 -......
Crystals, bbl., lb	.29¾-......	.25½-......	.23 -......
Zinc chloride, gran., bbl., lb	.06½- .06¾	.06½- .06¾	.06½- .06¾
Carbonate, bbl., lb	.10½- .11	.10½- .11	.10½- .11
Cyanide, dr., lb	.38 - .42	.38 - .42	.41 - .42
Dust, bbl., lb	.06¼- .06½	.04½- .06	.04½- .05
Zinc oxide, lead free, bag, lb	.05¾-......	.05¾-......	.05¾-......
5% lead sulphate, bags, lb	.05½-......	.05½-......	.05½-......
Sulphate, bbl., cwt	3.00 - 3.25	3.00 - 3.25	3.00 - 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.08¾-$0.09	$0.08¾-$0.09	$0.09½-$0.10
Chinawood oil, bbl., lb	.05¾-......	.05 -......	.05¾-......
Coconut oil, Ceylon, tanks, N. Y. lb	.03½-......	.03 -......	.03¾-......
Corn oil crude, tanks, (f.o.b. mill), lb	.04¾-......	.03¼-......	.02¾-......
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.04 -......	.02¾-......	.02½-......
Linseed oil, raw car lots, bbl., lb	.087-......	.074-......	.061-......
Palm, Lagos, casks, lb	.03¾-......	.02¾-......	.03½-......
Palm Kernel, bbl., lb	.04¾-......	.04½-......	.04½-......
Peanut oil, crude, tanks (mill), lb	.04¾-......	.03½-......	.02¾-......
Rapeseed oil, refined, bbl., gal	.40 - .42	.37 - .38	.37 - .38
Soya bean, tank (f.o.b. Coast), lb	nom.-......	nom.-......	nom.-......
Sulphur (olive foots), bbl., lb	.05 -......	.04¾-......	.04¾-......
Cod, Newfoundland, bbl., gal	.23 - .24	.21 - .22	.25 - .27
Menhaden, light pressed, bbl., lb	.041-......	.03¾-......	.04 -......
Crude, tanks (f.o.b. factory), gal	.10½-......	.09 -......	nom.-......
Grease, yellow, loose, lb	.03 -......	.02¾-......	.02 -......
Oleo stearine, lb	.05 -......	.03¾-......	.04 -......
Red oil, distilled, d.p. bbl., lb	.06½-......		
Tallow, extra, loose, lb	.03¾-......	.02¾-......	.02½-......

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb..	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb..	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal..	.22 - .23	.22 - .23	.20 - .21
Beta-naphthol, tech., drums, lb..	.22 - .24	.22 - .24	.22 - .24
Cresol, U. S. P., dr., lb.	.10½- .11	.10½- .11	.10½- .11
Cresylic acid, 97%, dr., wks., gal.	.42 - .45	.42 - .45	.49 - .52
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.04¾- .05	.04¾- .05	.03¾- .04½
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14¼- .15	.14¼- .15	.14¼- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	.90 - .95	.90 - .95	1.50 - 1.80
R-salt, bbl., lb.	.40 - .44	.40 - .44	.40 - .44
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.33 - .35
Solvent naphtha, w.w., tanks, gal.	.26 -......	.26 -......	.26 -......
Tolidine, bbl., lb.	.88 - .90	.88 - .90	.86 - .88
Toluene, tanks, works, gal.	.30 -......	.30 -......	.30 -......
Xylene, com., tanks, gal.	.26 -......	.26 -......	.26 -......

Price Changes During Month

ADVANCED	DECLINED
Ammonium sulphate	Butyl alcohol
Arsenic, red	Calcium chloride
Copper sulphate	Carbon tetrachloride
Lead oxides	
Potassium carbonate	
Tin salts	
Casein	
Vegetable oils	
Naval stores	

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton...	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.08½- .10½	.07 - .10½	.07 - .14
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb...	.02¼- .20	.02¾- .20	.02¼- .20
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.35 - .36
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.27 - .30
Carmine red, tins, lb.	3.65 - 3.75	3.90 - 4.50	5.25 - 5.40
Para toner, lb.	.80 - .85	.80 - .85	.75 - .80
Vermilion, English, bbl., lb.	1.20 - 1.30	1.10 - 1.20	1.45 - 1.50
Chrome yellow, C. P., bbl., lb.	.15 - .15½	.15 - .15½	.16 - .16½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.06 - .08	.06 - .08	.06 - .08
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.08½- .10½	.08½- .10½	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton...	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton.	40.00 -......	40.00 -......	40.00 -......
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	4.75 -......	3.90 -......	3.95 -......
Turpentine, gal.	.48 -......	.42 -......	.42 -......
Shellac, orange, fine, bags, lb.	.19 - .20	.19 - .20	.25 - .27
Bleached, bonedry, bags, lb...	.18 - .19	.18 - .19	.18 - .19
T. N. bags, lb.	.09½- .10	.08½- .09	.10 - .11
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton..	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton..	13.75 -....	13.75 -.....	13.75 -.....
Wax, Bayberry, bbl., lb.	.14 - .15	.14 - .15	.16 - .20
Beeswax, ref., light, lb.	.20 - .30	.20 - .30	.25 - .27
Candelilla, bags, lb.	.09 - .10	.11 - .12	.13 -......
Carnuba, No. 1, bags, lb.	.23 - .26	.20 - .22	.22½- .24
Paraffine, crude			
105-110 m.p., lb.	.02 -......	.02 -......	.03¼- .03¾

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	$200.00-.....	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%, ton.	68.00-.....	61.00-.....	72.00-75.00
Ferrochrome, 65-70%.	.09½-.....	.09½-.....	.10-.....
Spiegeleisen, 19-21% ton.	24.00-.....	24.00-.....	27.00-.....
Ferrosilicon, 14-17%, ton.	31.00-.....	31.00-.....	31.00-.....
Ferrotungsten, 70-80%, lb.	.94- 1.00	.94- 1.00	1.00- 1.10
Ferrovanadium, 30-40%, lb.	2.60- 2.80	2.60- 2.80	3.05- 3.40

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.07 -......	$0.05⅝-......	$0.05½-......
Aluminum, 96-99%, lb.	.229-......	.229-......	.229-......
Antimony, Chin. and Jap., lb.	.06½-......	.0595-......	.05¼-......
Nickel, 99%, lb.	.35 -......	.35 -......	.35 -......
Monel metal blocks, lb.	.28 -......	.28 -......	.28 -......
Tin, 5-ton lots, Straits, lb.	.36 -......	.25½-......	.20¾-......
Lead, New York, spot. lb.	.0365-.....	.03½-......	.03 -......
Zinc, New York, spot, lb.	.0407-.....	.0347-.....	.0275-.....
Silver, commercial, oz.	.33⅛-.....	.28 -......	.28 -......
Cadmium, lb.	.55 -......	.55 -......	.55 -......
Bismuth, ton lots, lb.	.85 -......	.85 -......	.85 -......
Cobalt, lb.	2.50 -......	2.50 -......	2.50 -......
Magnesium, ingots, 99%, lb.	.32 -......	.30 -......	.30 -......
Platinum, ref., oz.	28.50 -......	26.00 -......	40.00 -......
Palladium, ref., oz.	17.00 -18.00	16.00 - 17.00	19.00 - 21.00
Mercury, flask, 75 lb.	56.00 -......	54.00 -......	67.00 -......
Tungsten powder, lb.	1.25 -......	1.45 -......	1.45 -......

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	$6.50 -$8.25	$6.50 -$8.25	$6.50 -$8.25
Chrome ore, c.i.f. ports, ton.	14.00 -18.50	14.00 -18.50	17.00 -20.00
Coke, fdry., f.o b. ovens, ton.	2.25 -......	2.25 -......	3.25 - 3.75
Fluorspar, gravel, f.o.b. Ill., ton...	17.25 -20.00	17.25 -20.00	17.25 -20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit.	.19 -......	.19 - ...	.25 - .27
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.45 -......	.45 -......	.45 -......
Monazite, 6% of ThO_2, ton.	60.00 -......	60.00 -......	60.00 -......
Pyrites, Span. fines, c.i.f., unit.	.13 -......	.13 -......	.13 -......
Rutile, 94-96% TiO_2, lb.	.10 - .11	.10 - .11	.10 - .11
Tungsten, scheelite, 60% WO_3 and over. unit.	8.00 -10.00	8.00 -10.00	10.00 -10.50

INDUSTRIAL NOTES

WORTHINGTON PUMP AND MACHINERY CORP., on May 1, moved its general and executive offices from 2 Park Ave., New York, to the new office building adjacent to the company's plant at Harrison, N. J. The sales office will be continued at 2 Park Ave.

J. P. DEVINE MFG. CO. INC., Mt. Vernon, Ill., has moved its New York office from West 43d St. to 205 East 42d St. and its Chicago office from West Madison St. to 307 North Michigan St.

THE PATTERSON FOUNDRY & MACHINE CO., East Liverpool, Ohio, announce the appointment of M. Edgar Yeager, Chamber of Commerce Building, Boston, Mass., as New England district manager of stoker sales.

AMERICAN DRYICE CORP., on April 19 took over the business of the DRYICE CORP. OF AMERICA and has established executive offices at 205 East 42d St., New York City.

BLAW-KNOX CO., Pittsburgh, Pa. has taken up the manufacture and installation of brewery equipment. Carl Gille, chief engineer of Weigelwerk, A. G. of Germany, has come to this country and for two years will act in a consulting capacity as designer and builder.

NORTHERN EQUIPMENT CO., Erie, Pa., announces the appointment of George W. Neale as district representative for Florida, with the exception of Jefferson County and the counties west thereof. His office is located at 504 East Lafayette St., Tampa, Florida.

THE EARLE GEAR & MACHINE CO., Philadelphia, Pa., has moved its sales office in New York City from 95 Liberty St. to 149 Broadway.

THE BABCOCK & WILCOX CO. has added Mark R. Woodward to its cement equipment division. For the last 15 years Mr. Woodward has been assistant chief engineer of the Lehigh Portland Cement Co., in Allentown, Pa. He will be located in the Chicago office at 20 North Wacker Drive.

FOSTER D. SNELL, INC., Chemists-Engineers, has moved to 305 Washington Street, Brooklyn, N. Y., where larger quarters have been provided for both their offices and laboratories.

C. P. DEVINE AND CO., have combined their sales, engineering and fabrication business with the New York Engineering Co. which has its plant at Yonkers, N. Y., and offices at 25 W. 43d St., New York. The new company will specialize in chemical plants, vacuum fumigation and alloy fabrication. Associated with C. P. Devine in New York are Carl Koops and D. H. Chester. The chief consulting engineer is Robt. L. Holliday, formerly chief engineer of the General Chemical Co.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	This Month		Cumulative to Date	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England	....	$56,000	$165,000	$165,000
Middle Atlantic	$528,000	233,000	2,801,000	1,023,000
Southern	205,000	....	2,246,000	356,000
Middle West	58,000	132,000	701,000	657,000
West of Mississippi	9,313,000	....	10,001,000	876,000
Far West	227,000	....	882,000	988,000
Canada	880,000	50,000	2,930,000	211,000
Total	$11,211,000	$471,000	$19,726,000	$4,276,000

PROPOSED WORK BIDS ASKED

Aluminum Plant — South Manchurian R.R., Mukden, Manchuria, China, plans the construction of an aluminum plant at Fushun or Honkeiko, Manchuria. Experimental plant to cost $100,000 will be constructed first and used as basis of major project to cost $1,000,000. Address W. S. Dowd, Asst. Commercial Attache, Tokio, Japan, for further information.

Beet Sugar Refinery—Michigan Sugar Co., Owosso, Mich., plans to recondition its beet sugar refinery. Estimated cost $28,000.

Sugar Refinery — Sacramento River Farms, Ltd., Hamilton City, Calif., plans to recondition its beet sugar refinery here. Estimated cost to exceed $30,000.

Brick Plant—J. E. Bettens, Caledonia Crossing, N. S., plans to establish a brick plant at Mira, N. S., to have an initial capacity of 25,000 bricks per day.

Brick Plant—W. G. Bush Brick Co., Tower Island, Nashville, Tenn., plans to rebuild its brick plant recently destroyed by fire with a loss of $50,000.

Distillery—Stitzel Distilling Co., Story Ave., Louisville, Ky., plans the construction of a distillery. Estimated cost $65,000. C. J. Epping, East Broadway, Louisville, is architect.

Fat and Tallow Plant—V. R. Starling, Perry, Iowa, contemplates rebuilding his fat and tallow works. Estimated cost $28,000.

Gas Plant—City of Guymon, Okla., plans the construction of a gas plant. Estimated cost $50,000.

Gas Plant—City of Richmond, Ky., plans the construction of a gas plant and distribution system. Estimated cost $40,000.

Gas Bottling Plant—Skelgas Co. (subsidiary of Skelly Oil Co., 215 Eaton Ave., St. Paul, Minn.), F. J. Lee, Dist. Mgr., 4645 Humboldt Ave., No., Minneapolis, Minn., has had plans prepared for a 1 story, 30x100 ft. gas bottling plant at Minneapolis. Estimated cost $100,000.

Laboratory—National Motion Pictures, c/o H. W. Kier, South Texas Bank Bldg., San Antonio, Tex., are having plans prepared by N. Straus Mayfach, Alamo Bank Bldg., San Antonio, for a motion picture studio to include a 1 story, 42x60 ft. laboratory.

Laboratories — St. Peter's College, J. S. Dineen, Pres., 1 Newark Ave., Jersey City, N. J., plans the construction of a group of college buildings at Gifford Ave. and Hudson Blvd., Lincoln Park, to include ten scientific laboratories. Estimated cost $450,000. Paul Monaghan, 545 Fifth Ave., New York, is architect.

Leather Factory—H. Koch & Sons, manufacturer of leather goods, trunks, etc., 422 Natoma St., San Francisco, Calif., plan to reconstruct their factory recently destroyed by fire, with a loss of $75,000.

Paint Factory — Standard Chromate Co., Painesville, Ohio, contemplates the construction of an addition to its factory. Estimated cost to exceed $30,000 with equipment.

Paint Factory—C. J. Wyers, Brandon, Man., manufacturer of mixed paints, enamels, varnishes, etc., plans to build an addition to his factory.

Paper Plant—Eaton-Dikeman Co., Lee, Mass., has acquired a plant at Mount Holly Springs, Pa., and will recondition same and install new equipment. Estimated cost to exceed $50,000 with equipment.

Paper Plant — Greensville Paper Co., Ltd., Greensville, Ont., plans to build an addition to its plant.

Paper Plant — Osborn Paper Co., 218 Osborn St., Brooklyn, N. Y., plans alterations and repairs to its paper plant recently damaged by fire. Estimated cost $28,000.

Peat Fuel Plant—Fuels Development, Ltd., Alfred, Ont., plans to construct a plant here to have an output of 50,000 tons a year. This will be first of several plants to be opened by company (Canadian branch of British firm of Fuels Development, Ltd.) which is said to control a new patent for the production of peat fuel.

Wax Plant—Amberline Products, Ltd., Victoria, B. C., manufacturer of wax soaps and polishes, plans to enlarge its plant.

Wood Preserving Plant—Alberta Wood Preserving Co., Ltd., Swift Current, Sask., plans to build an addition to its plant.

Warehouse—Titan Chemical Products, Inc., Jersey City, N. J., Robert T. Grant, 242 Colonial Ave., Charlotte, N. C., Southern Sales Mgr., have established in Charlotte and plan the construction of a large warehouse and distributing plant to take care of entire southern territory.

Steel Mill—Gordon Steel Works, Ltd., Tweed, Ont., Can., plan to rebuild mill recently destroyed by fire. Estimated cost $50,000.

Refinery—Aurgus Gas Co., Hugoton, Kan., plans the construction of a gasoline refinery and supply line. Estimated cost $30,000.

Refinery—Bell Refining Co., Ltd., Calgary, Alta., plans to build an addition to its refinery.

Refinery—Corporation, c/o T. B. Jones, Moose Jaw, Sask., contemplates the construction of an oil refinery and storage plant here. Estimated cost with equipment $28,000.

Refinery — Gregg Refinery Co., Gladewater, Tex., plans to reconstruct its refinery recently destroyed by fire.

Refinery—Hydrogas Refinery Co., 25 King St., W., Toronto, Ont., contemplates the construction of an oil refinery.

Oil Refinery—Kirk Oil & Refining Co., c/o T. A. Kirk, Abilene, Tex., contemplates the construction of an oil refinery. Estimated cost $45,000.

Oil Refinery — Pan American Petroleum & Transport Co., subsidiary of Standard Oil Co. of Indiana, 910 South Michigan Ave., Chicago, Ill., plans to construct an oil refinery on a 450 acre site on the Houston Ship Channel, Houston, Tex. Estimated cost $9,000,000.

Refinery — Shell Oil Co., Shell Bldg., San Francisco, Calif., plans to rebuild bleacher unit of refinery at Martinez, Calif., recently destroyed by fire. Estimated cost $100,000.

Oil Storage Plant—Vancouver Harbor Board, Vancouver, B. C., will construct vegetable oil storage plants to have a capacity of 250,000 gal. at Hastings Mill site in Vancouver Harbor. Estimated cost $50,000.

Potash Refinery—Potash Co. of America, G. W. Harris, Pres., 302 Tramway Bldg., Denver, Colo., plans potash refinery at Carlsbad, N. M. This is correction of address published in April issue.

Cyanide Mill—Sheeptanks Consolidated Mines Co., Vicksburg, Ariz., plans to construct a 100 ton cyanide mill on its property here. Estimated cost $22,000.

Nitrogen Fixation Plant—Finnish Government plans to call for bids this summer for the construction of a nitrogen fixation plant to have a capacity of 4,000 tons per year, at Imatra Falls, Finland. It is understood that full details may be obtained at the Finnish Ministry at Washington, D. C.

Silicate Plant—National Silicates, Ltd., subsidiary of Philadelphia Quartz Co., 121 South 3rd St., Philadelphia, Pa., has purchased a factory site of approximately five acres in south end of Etobicoke Township, west of Toronto, Ont., and will build a plant for the manufacture of silicate of soda. Estimated cost $250,000.

Sodium Plant — Natural Sodium Products, Ltd., Moose Jaw, Sask., plans to build an addition to its plant at Dunkirk, Sask.

CONTRACTS AWARDED

Candy Factory—K-B Chocolate Co., Herman H. Koffman, 800 East Midland St., Bay City, Mich., awarded contract for 2 story addition to factory to W. J. DeFrain, Bay City. Estimated cost $75,000.

Chemical Plant — Diana Properties, Inc., Ridgefield Park, N. J., awarded contract for 1 story chemical plant to William J. Lange, Inc., 1025 Hoyt Ave., Ridgefield, N. J. Estimated cost $105,000. Address owner, care of contractor.

Gas Plant—Bridgeport Gas Light Co., 955 Main St., Bridgeport, Conn., will alter plant on Pine St., and install new equipment, foundation for gas purifier plant, and 10x18 ft. pump house. Owner will do work.

Glass Factory—Foster-Forbes Glass Co., East Charles St., Marion, Ind., awarded contract for glass factory to Bowman Construction Co., East Bradford St., Marion. Estimated cost $29,100.

Rayon Plant—Princeton, Inc., Echo Lake Rd., Watertown, Conn., awarded contract for timber tank and 2 story, 15x25 ft. plant for dyeing and treatment of rayon fabrics to R. G. Bent Co., 93 Edwards St., Hartford.

Facotry — Delta Oil Products Co., Granville, Wis., will build a 1 story, 45x120 ft. factory on Cedarburg Rd. Separate contracts have been awarded for the work.

Refinery—Sawyer Refining Co., Bolivar, N. Y., awarded contract for alterations and additions to its refinery to M. P. Brown Boiler Works, Franklin Pax, N. Y. Estimated cost $40,000.

Refinery—Triplex Oil Co., Review Ave., Long Island City, N. Y., plans to repair and recondition its oil refinery and distribution plant at June and Crescent Sts. Estimated cost with equipment $28,000. Work will be done by day labor.

Soap Factory—J. B. Williams Co. of Canada, 3552 St. Patrick St., Montreal, Que., awarded contract for soap factory at Ville la Salle, Montreal, to Laurentide Construction Co., 1253 McGill College, Montreal. Estimated cost with equipment $50,000.

Warehouse — Capstan Glass Co., Connellsville, Pa., awarded contract for 1 story, 100x200 ft. addition to warehouse to Connellsville Iron Works, Connellsville, Pa. Estimated cost $60,000.